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Final Environmental Assessment

99 State Street/Kilby Street Garage Project

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Project Proponent:
99 State Street Limited Partnership

Prepared by:
Edwards, Owings & Merrill
Vanasse/Hangen Associates, Inc
Parsons Brinckerhoff Quade & Douglas, Inc.
Roger Lang
Wright Brothers Facility, MIT

Submitted to:
The Boston Redevelopment Authority

December 1985

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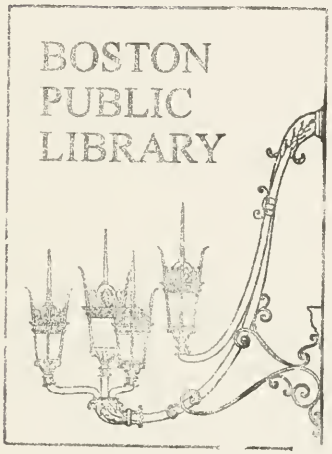

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Submitted To:
The Boston Redevelopment Authority

December, 1985

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I Summary: BRA Final Environmental Assessment*

99 STATE STREET/ KILBY STREET GARAGE PROJECT

The 99 State Street Project involves the redevelopment of a 1.37 acre area in the financial district of downtown Boston. The project fronts on portions of State Street and Kilby Street, and is located on a site currently occupied by the Kilby Street Parking Garage, a vacant lot, and several older commercial buildings in varying physical condition.

The project will result in the creation of a 700,000 square foot office building comprised of a low-rise base structure fronting the edges of the site, and a tower element set back from street frontage. The project includes approximately 15,000 square feet of retail uses located primarily along Kilby and State Street and within a ground-level retail arcade oriented to Merchants Row, a primary pedestrian link between the financial district and Quincy Market.

Pedestrian connections established by the project will reflect the area's history of through-block walkways. These connections will include a link between Merchant's Row and the project's retail arcade, and a connection between Kilby Street and Broad Street via a walkway aligned with Central Street and Exchange Place. Streetscape improvements to be created in the vicinity of the site will be planned in conjunction with the Boston Redevelopment Authority.

PROPONENT

99 State Street Limited Partnership

DOCUMENT STATUS

BRA Final Environmental Assessment

* This document has been prepared in response to the Boston Redevelopment Authority's environmental review process. It is not intended for official state-level review through the Executive Office of Environmental Affairs (EOEA). A separate document addressing issues specified by EOEA has been prepared for state-level review and was submitted as a Final Environmental Impact Report to EOEA on December 13, 1985.

ALTERNATIVES

This analysis addresses two alternatives--the project as planned and the No-Build scenario. Several design refinements, which have been made to the project since the BRA Draft Environmental Assessment was submitted in May, 1985, are discussed in Section III. A number of other design alternatives have been addressed in the BRA Draft Environmental Assessment, and as part of the design review process conducted in conjunction with the Authority and the Boston Society of Architects.

TRANSPORTATION

Analysis indicates that the proposed project will not pose detrimental effects to the area's transportation system. The project will utilize a site access and parking plan which relies primarily on Broad Street. Among the anticipated benefits of this approach are a reduction of vehicles on Kilby Street, improved access to the site via the underutilized Broad Street corridor, isolation of parking trips from delivery activity at Kilby Place, isolation of parking trips from the project's pedestrian entrances, and elimination of all sidewalk breaks along Kilby Street between Exchange Place and State Street.

Analysis has been conducted concerning the potential effects of the project at nine major area intersections for the year 1990, including expected traffic associated with various other projects planned or under construction in the vicinity. At all but one intersection, levels of service are expected to be unchanged or to remain well within acceptable ranges. Moderate project-related effects at the intersection of State Street and Broad Street will result in a change from level of service B to level of service D, still considered to represent an acceptable operational condition.

The provision of long-term parking within the project is generally consistent with expected levels of demand. Although it is anticipated that short-term parking demand may exceed capacity, mitigation measures such as pricing and parking management policies are expected to minimize such conditions.

Widening and realignment of sidewalks proposed as part of the project will provide for acceptable pedestrian flows in the area. Increased demand on the public

transportation system is not expected to result in any significant impact on rapid transit lines.

AIR QUALITY

Ambient air quality was assessed by performing a micro-scale analysis of carbon monoxide (CO) concentrations at three sensitive receptors adjacent to the intersection of State Street and Broad Street in the project study area, and at two sensitive receptors on the development site. The analysis examined existing (1985) concentrations, as well as the no-build and project build alternatives in 1990.

Modeling results indicate existing CO concentrations are in compliance with the National Ambient Air Quality Standards (NAAQS) at this intersection. The CO predictions for 1990 show a significant improvement in air quality as a result of continued enforcement of the Commonwealth's Inspection and Maintenance Program for motor vehicles and the continuing trend toward cleaner vehicle emissions. Predicted CO concentrations in 1990 show that levels at all sensitive receptors will be in compliance with the NAAQS for both the build and no-build alternatives. It can be concluded that the 99 State Street project will not interfere with the attainment or maintenance of the NAAQS for CO. Project related increases in CO levels are insignificant.

WATER AND SEWER SERVICE

The 99 State Street Project will result in the establishment of a system of sewers from Liberty Square to McKinley Square in which sanitary and storm flows can be carried separately, rather than in a combined system as currently exists. This new system will replace a 67" combined sewer line which runs below the Kilby Street Garage, and which will be discontinued in order to allow for garage demolition and subsurface construction. The new system will also replace a 12-inch combined sewer in Kilby Street which is not functioning in the vicinity of the project. A new site drainage system will be designed to discharge into the new storm drain system, which will also collect storm flows from adjacent buildings along its route. The new storm drainage system will be of sufficient capacity to facilitate separation of sanitary and storm flows from a total contributing area of up to 22 acres in the

future, when it is extended upstream of the project area by the Boston Water and Sewer Commission.

The project is not expected to result in any increased runoff, but will result in an increased discharge of sanitary sewage of 39,800 gpd. Increased water demand as a result of the project is estimated at 44,300. Other project related effects include the extension of high pressure fire service lines in Broad and Kilby streets in order to re-establish loop service terminated as a result of abandonment of a high pressure line in Doane Street. A full discussion of project related effects on the area's water and sewer system can be found in Section IV-C.

WIND

Hot-wire tests, conducted at the MIT Wright Brothers Memorial Wind Tunnel, were used to investigate pedestrian-level wind conditions at 24 specific locations in and around the project site. Test results suggest that project development will not cause pedestrian-level wind conditions to exceed wind guidelines established by the BRA.

SHADOW

A series of computer-generated shadow analyses have been performed for the 99 State Street Project to predict and evaluate the extent of new project-generated shadows. Shadow analysis indicates that, for the most part, the development will not result in significant shadow effects in the vicinity of the project. During limited periods at various points in the project area, the proposed project was found to add only extremely small areas of increased shadow. This minimal impact is achieved, in part, by the removal of the 184-foot 89 State Street building, and the set-back position of the project's tower element.

Shadow analysis previously conducted for the BRA Draft Environmental Assessment included a detailed evaluation of effects to an important pedestrian area between Faneuil Hall and the Central Quincy Market building, known as the "Jugglers Area." Analysis indicated that only during morning hours in late Fall and early Spring do limited shadow effects occur in the Jugglers Area. The analysis also indicated that no new shadows are created in this area during lunchtime peak use periods.

HISTORIC RESOURCES

The immediate surroundings of the project include nineteenth and twentieth century commercial structures to the south fronting on Liberty Square, to the east facing Broad Street, and on the north side of State Street. The project is located adjacent to the Custom House National Register District, with one project related parcel included within the District's boundaries.

The scale and massing of the project has been designed to respond sympathetically to its historic context. This includes the use of a low-rise base element establishing a consistent cornice height along State and Kilby Streets; the establishment of pedestrian connections which reflect the area's history of through-block walkways; the use of materials and rhythm of fenestration which reflect that of nearby historic structures; and the creation of new views of historic structures, notably a new view of the Custom House Tower from State and Congress Streets. In order to preserve the character of the project area, the proponent has secured height and mass restrictions on most of the remaining properties which make up the block bounded by State, Kilby, Water and Broad Streets. In addition, the project will include improvements to Merchants Row, the primary pedestrian connection between the project area and the historic Quincy Market area. These improvements are discussed in Section IV-F.

Analysis of existing buildings on-site indicates that the architectural and historical significance of these structures is negligible. This includes the Fiske Building at 89 State Street, which was massively altered in 1964, as well as the 99 State Street building, which appears to play only a minor contributory role in the Custom House District and which has been rated by the Boston Landmarks Commission as having "minor significance." A full discussion of the effect of the project on surrounding historic resources can be found in Section IV-F.

ARCHAEOLOGICAL RESOURCES

Archaeological work to-date on the 99 State Street site has occurred during the Summer and Fall of 1985. Work conducted prior to the Draft EIR (August 1985) included documentary research of past site usage; an examination

of cellar depths; an assessment of fill depths on the basis of geotechnical corings; and analysis of potential site disturbance resulting from past activities such as cellar construction, emplacement of foundation structures, and utility location.

Work conducted since submission of the Draft EIR has included archaeologically controlled trenching, coring, and hand tests as well as archaeological monitoring of preconstruction tests.

This research indicates that the site was actively utilized as early as 1630, and continued to be a prominent commercial district throughout its subsequent development. Past activities on-site which have disturbed archaeological deposits include cellar construction, the emplacement of foundation structures, and the location of utilities.

Subsurface testing has indicated that significant disruption of a large portion of the site has occurred, due primarily to the construction of basements to depths which approach or exceed the depth of fill on-site. No significant archaeological resources have been discovered as a result of these subsurface tests.

In areas of the site at which the presense of archaeological resources or of subsurface disturbance has not yet been determined, further testing is planned. This will include additional trenches, borings, test pits and participation in a variety of construction-related activities such as utility relocation and preliminary excavations.

CONSTRUCTION

The construction process for the 99 State Street Project has been planned to ensure that environmental effects to the surrounding area are minimized. A construction management consultant has been retained in order to coordinate the process, and to facilitate communications with pertinent public agencies and other interested parties.

Demolition is scheduled to occur in Spring of 1986. No use of explosives is planned. Site-wetting will be utilized to reduce demolition-related dust.

Excavation and foundation construction is scheduled for Fall of 1986. A slurry wall system will be utilized, minimizing ground movement in adjacent areas. Pile driving will not be associated with the predominant foundation support system. No impacts to the MBTA Blue Line tunnel below State Street are expected.

Erection of steel framing is scheduled for Winter of 1986 and Spring of 1987. Construction of the building's facade and exterior elements is scheduled for the Summer and Fall of 1987. In general, a tower crane will be utilized for the majority of this work in order to avoid impacts to street operations which might be associated with a mobile crane.

Truck access will occur via State Street from the Central Artery. Truck egress will occur via Milk Street to Broad Street to the Central Artery. Discussion is in progress with appropriate city agencies, such as the Traffic and Parking Department, Public Works Department, and Fire Department, in order to further refine the a traffic maintenance program to be utilized during the construction process.

II Project and Area Description

PROJECT DESCRIPTION

The 99 State Street/Kilby Street Garage Project will result in the creation of a 700,000 square foot office building on State Street in Boston's financial district. The project will be comprised of a low-rise base element and a set-back tower element, and has been designed to be compatible with the scale and character of development in the surrounding area. The program of planned uses, which includes a ground-floor retail component of approximately 15,000 square feet, has also been developed to reflect the overall character of land uses in this section of the city. A more detailed description of the proposed building design can be found in Section III - Description of Alternatives.

The project will establish a system of pedestrian connections which will reflect the area's history of through-block pedestrian walkways. These will include a ground-level retail arcade oriented to Merchants Row, an important pedestrian link between the financial district and Quincy Market. The project will also establish a pedestrian link between Kilby and Broad Street via a walkway aligned with Central Street and Exchange Place. Streetscape improvements will be provided in the vicinity of the site, and Merchants Row will be physically upgraded using brick, granite, and other materials compatible with the Faneuil Hall Marketplace.

Up to 700 on-site parking spaces below grade are currently planned for the development. Garage access/egress will be from Broad Street via a depressed ramp on a portion of what is now Doane Street, which will be closed. By relocating the existing Kilby Street garage entrance/exit to this point, traffic will be removed from the area's most congested intersections. The new garage will also result in shorter queuing periods for vehicles waiting to park on-site. Loading and receiving will occur at-grade via Kilby Place, located away from vehicular and pedestrian traffic.

In addition to establishing an attractive new building in Boston's financial district, the project will enhance the visual quality of the area in a number of other ways. These include the elimination of an unattractive garage structure, the elimination of a vacant lot on a prime downtown corner, the creation of coherent commercial street frontage, and the creation of a new vista of the historic Custom House Tower seen from State and Congress Streets (see Exhibit IV F-7).

The 99 State Street Project has been designed in response to guidelines prepared by the BRA and Boston Society of Architects (BSA) specifically for development of this site. Refinement of this design is continuing in consultation with the BRA and BSA as part of an ongoing design review process. Several design refinements, which have been made to the project since the Draft Environmental Assessment was submitted, are discussed in Section III.

PROJECT SITE

The 99 State Street site consists of approximately 1.37 acres in Boston's financial district within an area fronting on State Street to the north and Kilby Street to the west (see Exhibit II-2). The site is bounded to the south by Kilby Place and a privately owned dead-end alleyway which runs behind buildings fronting on Water Street. Kilby Place is presently used for access to the Kilby Street Parking Garage. The site's eastern boundary follows property lines located on the interior of the block, and does not consist of any frontage on Broad Street.

Land uses currently existing on-site consist primarily of office buildings and ground-floor retail facilities. The total of office and retail uses on-site is approximately 140,000 square feet. The project site is completely developed, with the exception of a vacant parcel at the corner of Kilby Street and State Street. The vacant parcel is currently used as a parking lot and as the location of a photographic-processing kiosk.

Located on Kilby Street, between Doane Street and Kilby Place, is the ten-story Kilby Street Mechanical Parking Garage, the original property targeted for redevelopment by the BRA within the project area. Exterior materials of the Garage consist of light yellow brick and multi-colored panels uncharacteristic of development in the surrounding area.

Located within the site at #89 State Street, directly across from Merchants Row, is the Fiske Building. Originally a granite-faced Romanesque office structure, the Fiske Building was inappropriately altered in 1964 when the decorative tower and facade cornices were destroyed, and a blue aluminum and glass curtain wall was installed. At sixteen stories, the building is

Exhibit II-1

LOCUS MAP
99 State Street/Kilby Street Garage Project
Boston, Massachusetts

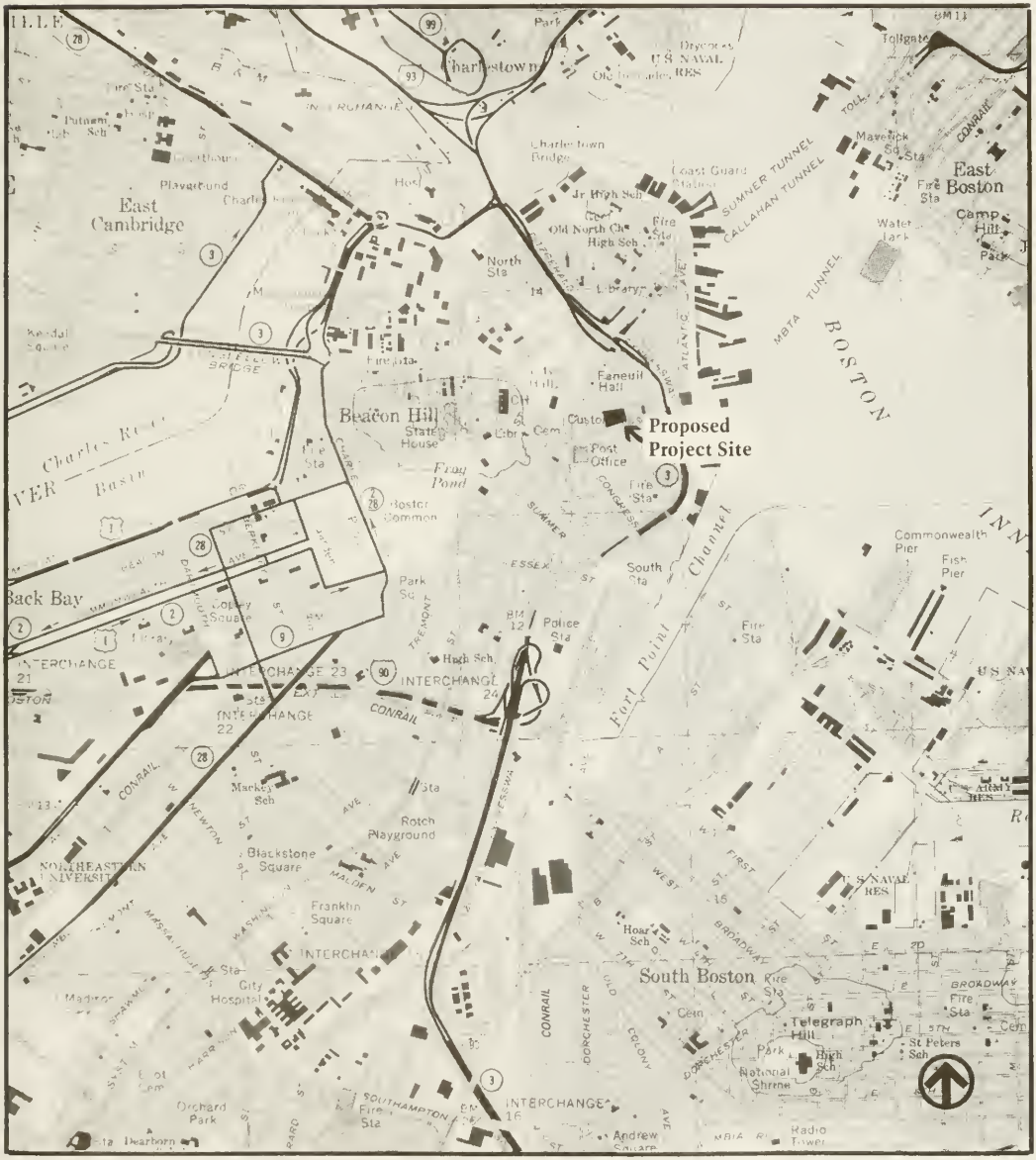
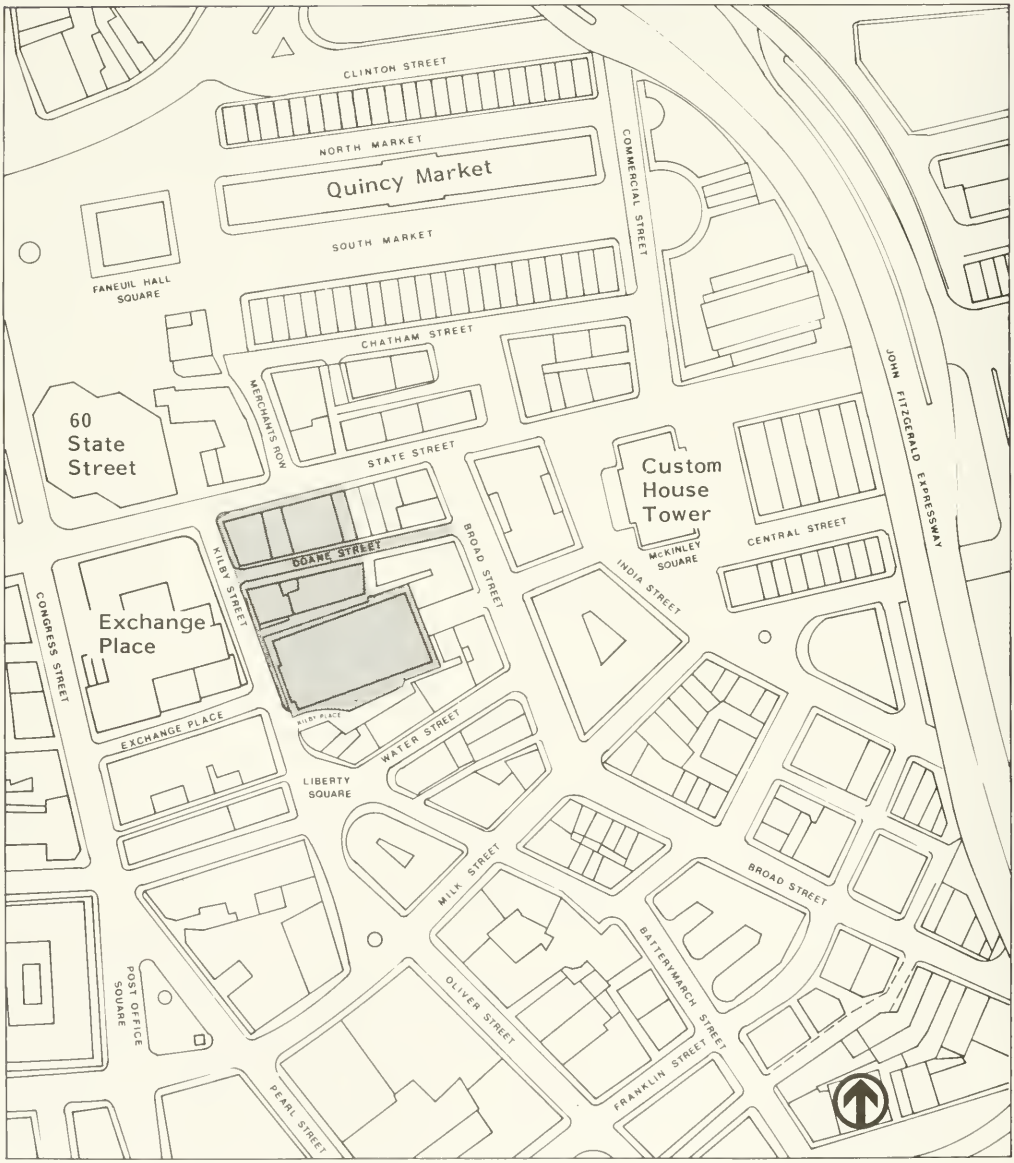


Exhibit II-2 SITE CONTEXT MAP



1"=200'

highly visible from views along State Street, and is inconsistent in terms of style and materials with buildings in the area (see Exhibit IV F-3).

Other buildings on-site include two older five-story commercial buildings standing on either side of the Fiske Building, a larger seven-story brick commercial building at #5 Doane Street, and a nine-story granite faced building at #20 Kilby Street.

AREA DESCRIPTION

The 99 State Street Project is located at the northern edge of the city's financial district, just south of Quincy Market. The character of structures in the vicinity of the project site reflect the area's origins as a turn-of-the-century commercial center, as well as its subsequent development as the home of a variety of major real estate, banking and other financial institutions.

The site is located in an area of high-rise structures averaging approximately 40 stories and exceeding 400-450 feet in height. These include Exchange Place, 60 State Street, and One Post Office Square, as well as the Custom House Tower. Building heights of older structures to the south and east of the project are generally in the range of 75 to 150 feet. Development in the area ranges from modern high-rise structures to a variety of older architectural styles including Romanesque, Beaux Arts, Federal and Classical Revival. Building materials consist primarily of brick and granite, with structures set uniformly at the street line.

The project area is the site of considerable pedestrian activity during working and commuting hours. A principal focus of pedestrian activity in the vicinity of the project is Quincy Market, where a wide variety of restaurants and shops cater to the area's large employee population, as well as to a significant number of tourists. Quincy Market is linked to State Street by Merchants Row, located directly across State Street from the project site. Merchants Row is a small paved roadway leading directly into the brick-paved pedestrian plaza surrounding Quincy Market, and lined with retail establishments along both sides.

To the west of the site is another center of pedestrian and vehicular activity at the intersection of State Street and Congress Street. This intersection is the site of pedestrian activity generated by the financial district, Quincy Market, and various MBTA transit stations, including the State Street, Government Center and Haymarket Stations.

To the south of the project is Liberty Square, located at the intersection of Kilby Street, Water Street, Batterymarch Street and Oliver Street. The Square currently centers on a large expanse of open pavement. A landscaped traffic island, financed by neighboring businesses, is planned for construction in Liberty Square.

Central Court, also known as Hamilton Park, is located adjacent to the site at the western terminus of Central Street. The area consists of a small landscaped courtyard, with entrances to neighboring buildings on each side.

Roadways

State Street is a major one-way connector roadway for westbound vehicles, linking Atlantic Avenue and the Waterfront area to Congress Street, the financial district and Government Center. Kilby Street is a one-way local street paralleling Broad Street, and linking Liberty Square to State Street. Broad Street is a wider two-way roadway travelling north-south through the financial district. Doane Street is a narrow one-way roadway linking Kilby Street to Broad Street.

DESIGN/DEVELOPMENT PROCESS

The development proposal presented for analysis in this document has been part of an ongoing design review process conducted in conjunction with the Boston Redevelopment Authority (BRA) and the Boston Society of Architects (BSA). The process was initiated in 1982, when the Kilby Street Garage parcel was advertised by the BRA for development interest. As a result of this solicitation, the Authority received five preliminary development proposals. In December 1983, the City issued Tentative Designation to the 99 State Street Joint Venture as redevelopers of the Kilby Street garage facility and the adjacent discontinued portions of Doane Street. The 99 State Street Joint Venture had also acquired rights to 89 State Street and 5 Doane Street by that time, producing a development site of approximately 44,460 square feet.

In April 1985, the Tentative Designation was revised and reaffirmed by the BRA based upon the following modifications:

- The addition of The Beacon Companies as a member of the development team resulted in its reconstitution as the 99 State Street Limited Partnership, hereafter referred to as the Proponent.

- Responding to direction from the City to expand the development parcel, the Proponent acquired rights to several adjacent parcels, including 75 State Street, 85 State Street, and 20 Kilby Street. The development site established as a result of these acquisitions totals 60,018 square feet.

- In order to preserve the character of the vicinity of the site, the Proponent secured height and mass restrictions on most of the remaining properties which make up the block bounded by State, Kilby, Water and Broad Streets (see Exhibit IV F-9).

These changes led to revision of the project's development program and design. The acquisition of additional parcels made it possible to increase the allowable square footage of the project from a previous figure of 550,000 square feet to a gross floor area allowance of 700,000 square feet. An FAR of 10, as allowed by the Boston Zoning Code, was applied to these additional acquisitions, which total approximately 15,000 square feet of land. Programmatic changes included additional

on-site parking and a reduction in retail space from a previous figure of 50,000 square feet to approximately 15,000 square feet.

In May 1985, the Proponent submitted a Draft Environmental Assessment of the project to the BRA. The document addressed a broad range of issues, including traffic, water and sewer service, wind, shadow, daylight, historic resources and construction effects.

Since then, the Proponent has received Design Concept Approval and Schematic Design Approval from the BRA. In July, the Boston Public Facilities Department approved and executed the sale of the Kilby Street Garage and Doane Street to the project Proponent. In August 1985, a Draft EIR for official state-level review was submitted to the Executive Office of Environmental Affairs (EOEA), and was determined to be adequate by the EOEA Secretary.

ALTERNATIVES

No-Build Alternative

The no-build alternative is included in this analysis in order to compare effects of proposed development with the effects of maintaining existing conditions on-site. This alternative assumes that no redevelopment activity will occur. Existing conditions on-site are described in detail in Chapter II--Project and Area Description. In general, the project site consists of a surface parking lot, a mechanical garage and multistory office buildings. The site contains approximately 140,000 square feet of office and retail uses.

The No-Build Alternative entails the continuation of a number of undesirable environmental conditions which would be rectified as a result of proposed development. Among these are the negative effects of the Fiske Building at 89 State Street, which poses a highly visible building element inconsistent in terms of style and materials with the adjacent Custom House Historic District, and which obscures views of the Custom House Tower as seen from State and Congress Streets (see Exhibit IV F-7). Also inconsistent with surrounding development is the Kilby Street Parking Garage, the Fotomat kiosk on State Street, and the surface parking lot at the corner of Kilby and State Street. Other

undesirable existing conditions include the presence of a system of combined sanitary and storm sewerage, which contributes to sewage overflow problems in the city of Boston. The effect of proposed development on these and other existing conditions is described in Section IV--Environmental Issues.

Proposed Development

A variety of design alternatives have been developed and reviewed with the BRA and the Boston Society of Architects (BSA) to determine the height and massing solution which is most desirable in terms of the building program, the aesthetic issues associated with surrounding development, and potential impacts such as wind and shadow. The development scheme discussed here, and shown in Exhibits III-1 through III-4, is a product of this design review and refinement process, as well as additional discussions with interested community groups, review boards and private entities.

The project's massing will be comprised of a low-rise base element fronting all edges of the site, and a stepped tower element set back from street frontage. The configuration of these elements has been designed to complement the scale and massing of neighboring structures, and to avoid or minimize the creation of wind or shadow effects in the vicinity of the project. Comparing the current 700,000 square foot building program with the project's 60,018 square foot site results in a total project floor area ratio (FAR) of 11.69, well below the Boston Redevelopment Authority (BRA) requirement for a maximum 12.25 FAR for this site.

The plan for the 99 State Street Project was given Design Concept Approval by the BRA in July 1985. After reviewing several design revisions which were subsequently incorporated into the project, the BRA issued Schematic Design Approval in November 1985.

As a result of these revisions, the height of the set-back tower element has been reduced by approximately six feet, and is now at 389.5 feet (including mechanical). At this height, the tower provides a transition in scale between the higher development to the west--including Exchange Place and Sixty State Street--and the lower development within the Custom House District to the east. The design of the tower

includes a variety of lower elements which step up toward the tower's center, where it reaches its full height. Also a result of design revisions, the tower setback from Kilby Street is now 32 feet, an increase of approximately 15 feet compared with the previously approved scheme. The base element is now 78 feet in height, as compared with 70 feet in the previously approved scheme.

The project's exterior will consist of masonry compatible with the materials and fenestration of older commercial structures in the surrounding area. This will include the use of granite for the facade of the tower, and special attention to the texture and pattern of the building facade and fenestration to create interest and maintain compatibility with area buildings. Of particular interest in the design approach will be a low-rise base element with frontage on State Street and Kilby Street, where variety in facade articulation and a careful use of brick and granite will contribute to an improved pedestrian experience. Other aspects of the proposed project are discussed in Chapter II--Project and Area Description.

Exhibit III-1 GROUND FLOOR PLAN

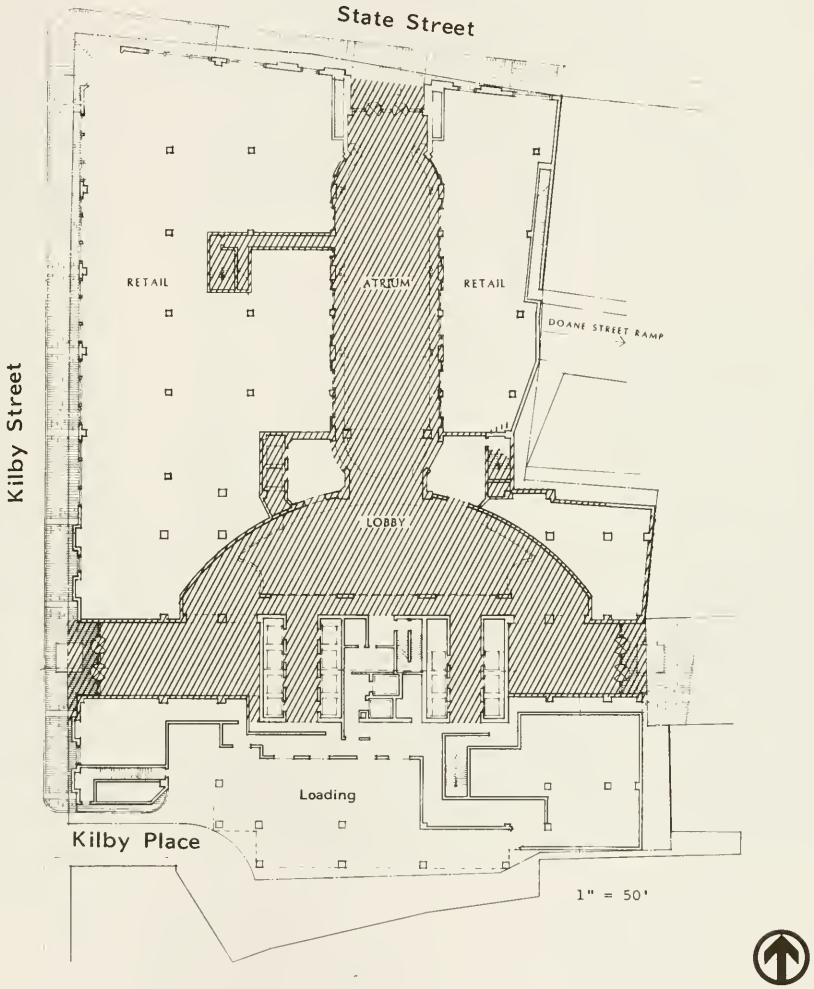
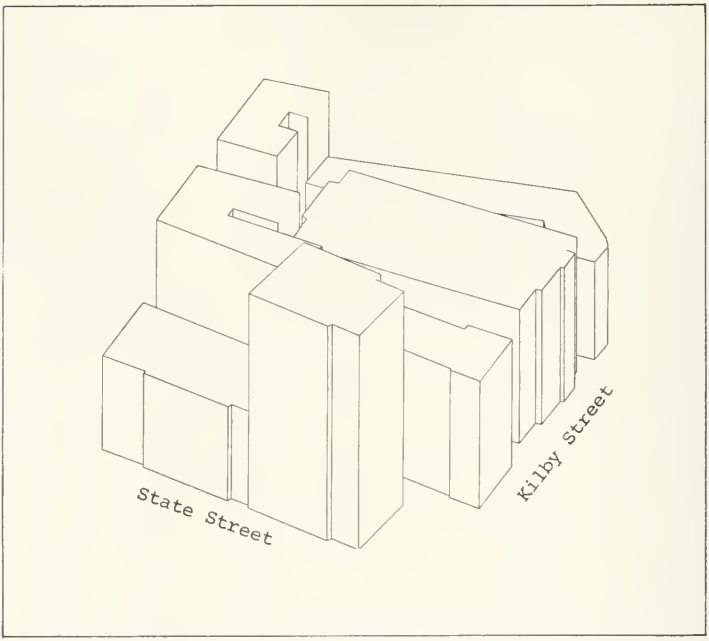
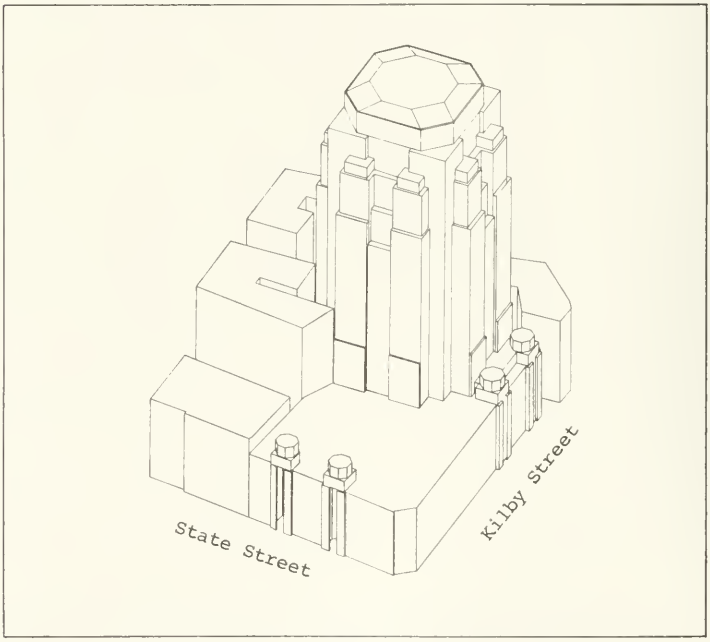


Exhibit III-2

AXONOMETRIC VIEW



Existing Conditions



Proposed

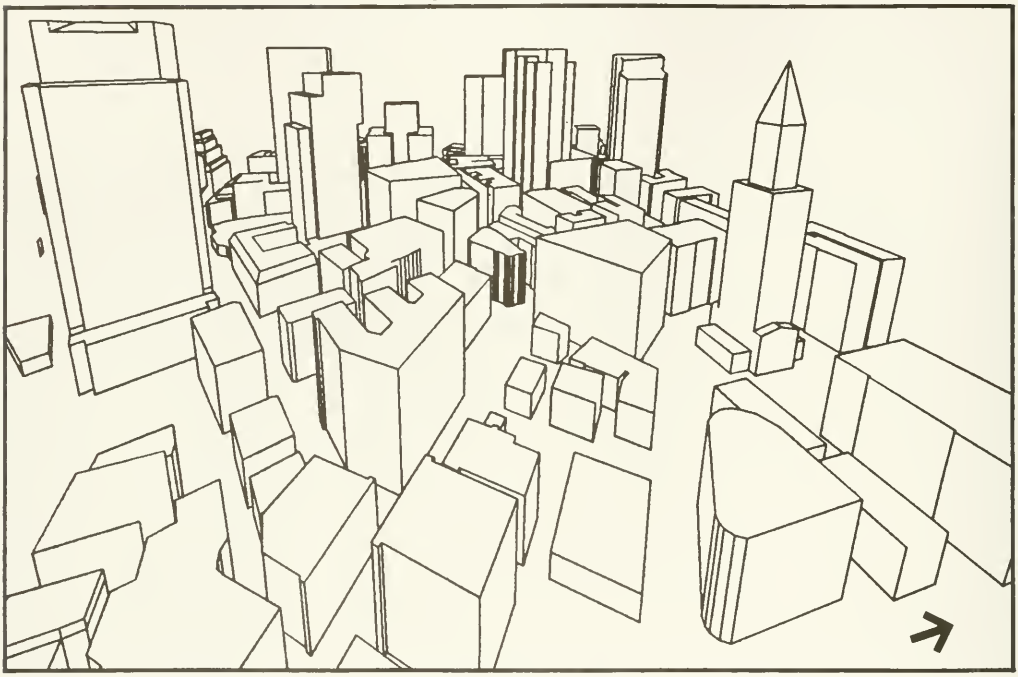
Exhibit III-3

RENDERING OF PROJECT

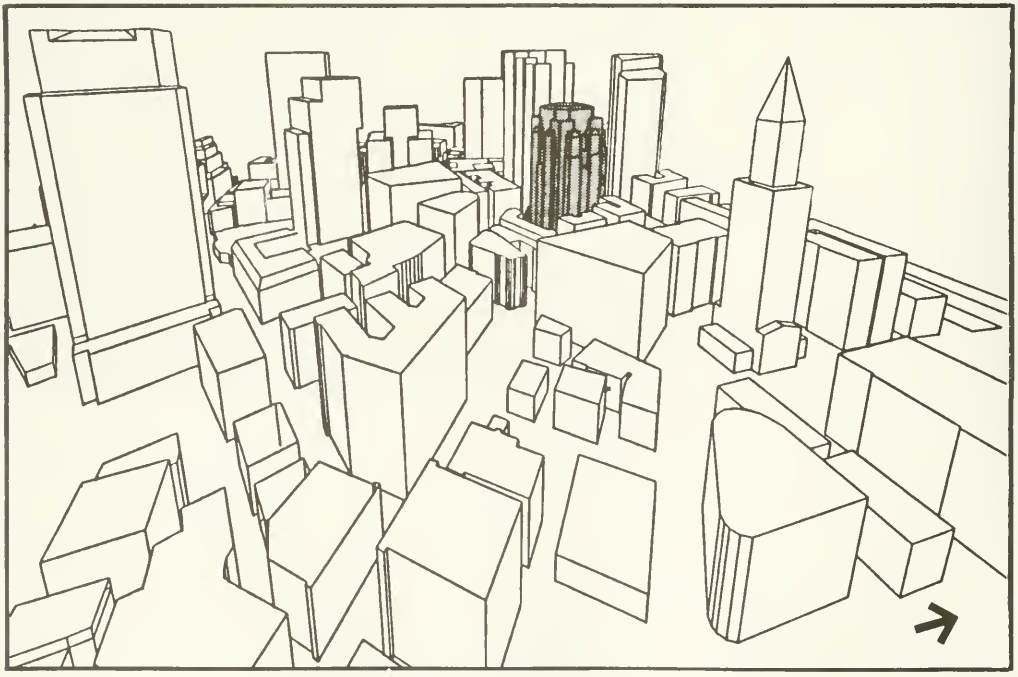
State Street

Exhibit III-4

SKYLINE VIEW:
Existing



Proposed



IV Environmental Issues

INTRODUCTION

In May 1985, the Proponent submitted a Draft Environmental Assessment concerning this project to the Boston Redevelopment Authority (BRA). The document was subject to a public and agency review process, and a letter was issued by the BRA requesting additional data and analysis to be submitted in a Final BRA Environmental Assessment. As agreed upon with the BRA, the following environmental issues pertinent to the project are discussed in this chapter:

A. Transportation

B. Air Quality

C. Water and Sewer Service

D. Wind Conditions

E. Shadow Conditions

F. Historic Resources

G. Archaeological Resources

H. Construction

Transportation

INTRODUCTION

This section describes existing traffic related conditions in the Project's Study Area, estimates the impact of the development in terms of vehicle and pedestrian trips to the site and provides an analysis of the study area under existing and future (1990) conditions. As a benchmark, it provides an analysis of conditions in the forecast year without development of 99 State Street, but with other projects currently under construction and/or approved.

Summary of Findings

The analysis contained herein suggests that the development of the 99 State Street parcel will not have a significant impact on the area's transportation related infrastructure. The relocation of access to the site's parking facility from Kilby Street to Broad Street will result in improvement of operation on Kilby Street with the opportunity provided to improve pedestrian circulation and walking conditions on the easterly side of the roadway. It will also provide immediate access to Broad Street, the widest local roadway in the area, which now experiences use well below capacity. The relocation of all vehicle trips approaching and exiting the existing Kilby Street Garage, coupled with new trips to the site will have a moderate impact on the operations at the State Street/ Broad Street intersection. However, that location will still function at an acceptable level of service. Other areas impacted by the development will show only slight increases in traffic flow when compared with conditions prevalent in 1990 based upon solely on background growth.

Between 1985 and 1990 transit use is expected to increase by approximately 20 percent based on background growth in the Downtown area. With the MBTA now in the final stages of improvements on both the Orange and Red Lines, an expansion from four-car to six-car trains is anticipated prior to 1989 on both. This coupled with new equipment on the Green Line will result in a substantial increase in capacity which will exceed background growth and the addition of trips from the development.

The 99 State Street development will include the construction of a 700-space parking garage, totally

below grade. Four hundred and fifty of these spaces are intended as replacement of the effective capacity of the existing Kilby Street Garage with 250 allocated to the development. The analysis indicates that the long-term commuter parking demand associated with the project will result in an increased demand for parking of between 270 and 400 spaces. The former is based upon the existing mode split to buildings in the immediate area, while the latter is on an areawide basis. Short-term, non-employee demand is expected to increase by approximately 150 vehicles.

Mitigating actions have been identified to further reduce the impact of development. These include several traffic operations improvements, the widening of sidewalks adjacent to the site, the promotion of programs to reduce the long-term commuter parking demand, and to improve the short-term parking supply.

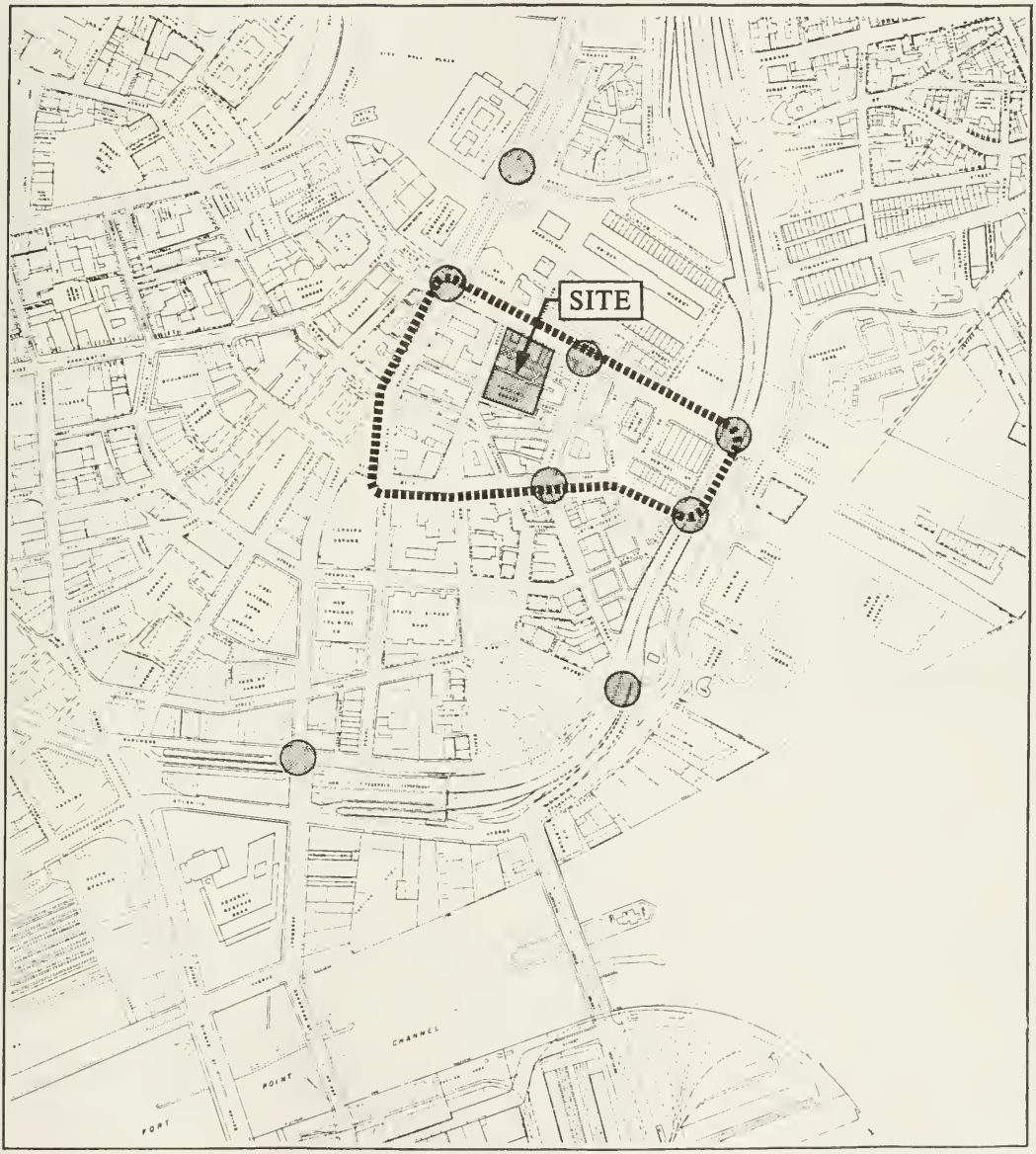
The 99 State Street Project

The development site has frontage on both State Street and Kilby Street. The Kilby Street frontage includes the closure of Doane Street.

The proposed development will consist of approximately 685,000 square feet of office space and 15,000 square feet of retail space with a completion date in late 1988 or early 1989. Not all of this space is new as the proposed development site already contains approximately 140,000 square feet of mixed retail/office floor space. Consequently, the new net floor area is about 560,000 square feet.

The project will also supply approximately 700 parking spaces. This does not represent a 700-space increase in the parking supply. A portion of the development site is now occupied by a surface lot at the corner of Kilby and State Streets serving approximately 25 vehicles, and by the Kilby Street Garage, an elevator facility with approximately 700 spaces. However, the effective capacity of the garage is 450 vehicles, because of elevator capacity and access to spaces within the structure. This facility will be demolished to make room for the project, resulting in a net gain in parking on the site of approximately 250 spaces. Primary vehicular access to the new parking garage will be provided via Broad Street.

Exhibit IV A-1 STUDY AREA



Study Area

The study area defined for this project includes links and major intersections within a perimeter bounded by the Surface Artery to the east, State Street on the north, Congress and Pearl Streets on the west and Milk Street on the south. In addition, three intersections beyond this perimeter were identified by the BRA as possible impact areas. These include:

1) Congress Street at North Street
2) Congress Street at Purchase Street
3) Surface Artery/Atlantic Avenue/High Street/ Broad Street

The Study Area is illustrated in Exhibit IV-A-1.

Public transportation in this area is also well developed and utilized. The MBTA's four rapid transit lines may be directly accessed from five stations within 2,000 feet of the site, the closest being the State Street station (Orange and Blue Lines). Commuter Rail services from both North and South Stations, Commuter Boat and Express Buses to the north, south and west are all accessible within one-half mile of the site.

Study Methodology

The transportation study was conducted in three distinct phases. Phase I involved inventorying the existing conditions and travel demand characteristics in the area. The inventory included researching previous transportation reports as well as conducting new observations of the area travel demands. Observations of traffic volumes were conducted during the morning and evening peak periods at several key intersections serving the site. These counts included pedestrian crossings. In addition, transit line performance and ridership data were researched from MBTA files. Parking and operation data for the Kilby Street garage was also evaluated.

Phase II of the study built upon the data base in Phase I and established the framework for evaluating the transportation impacts of the proposed project. In this phase, travel demand forecasts for the project were assessed along with forecasted demands created by other future area developments. An analysis year of 1990 was

established. Estimates were made for all transportation modes with emphasis placed on vehicular traffic and parking demands.

Phase III, the final study phase, included evaluation of the impacts of the project on the transportation and pedestrian system and identification of measures to mitigate any adverse impacts.

EXISTING CONDITIONS

Roadway Network

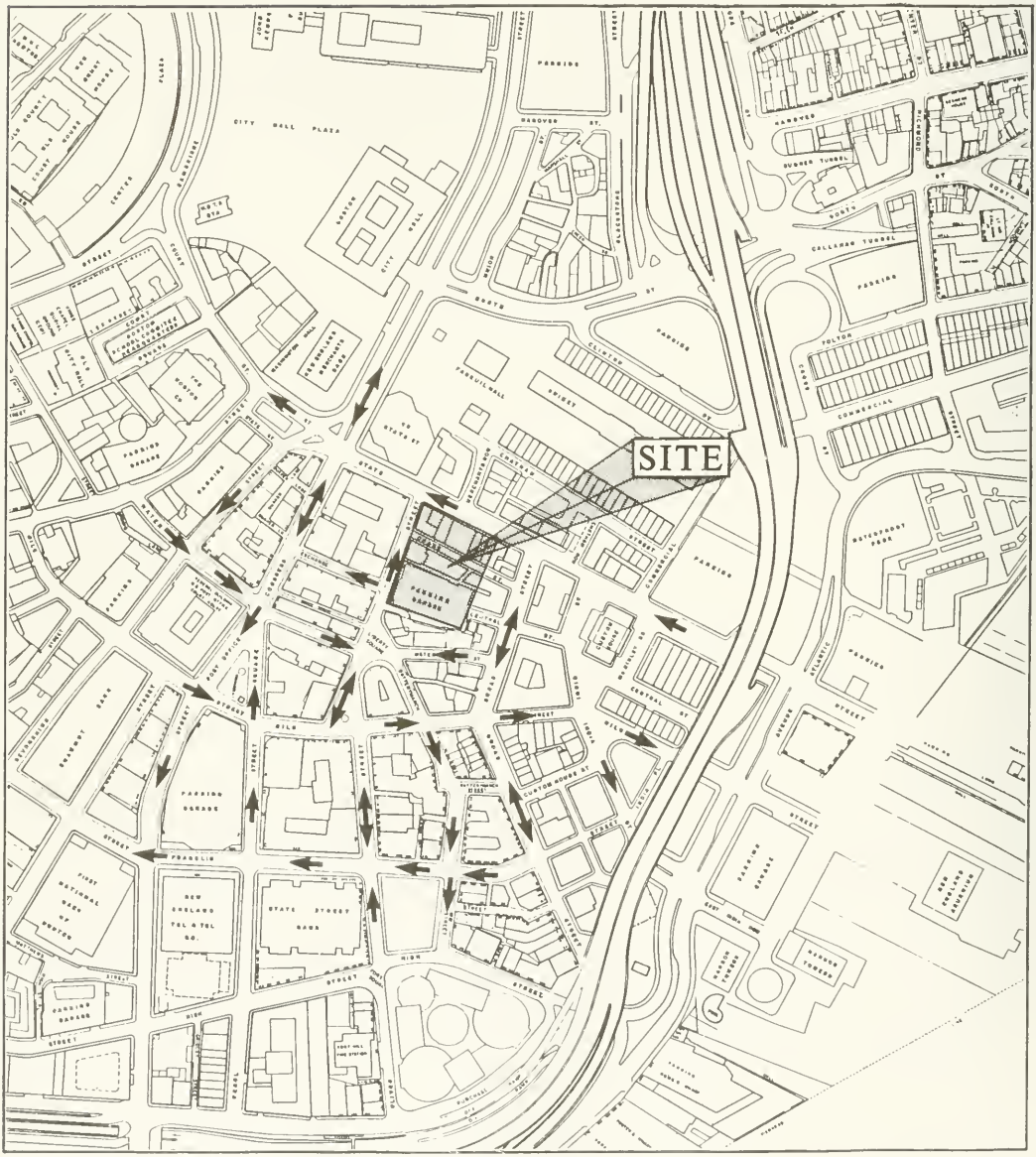
In addition to Kilby Street and State Street, roadways in the area which will provide access to the immediate site include Broad Street, Water Street and Exchange Place. Access to the regional highway system is provided by the Surface Artery, State Street and Congress Street. Exhibit IV-A-2 illustrates the roadway circulation pattern now existing in the area. The following provides a brief summary of roadway characteristics:

- Congress Street - a major north/south artery west of the site connecting the Government Center area to the South Station area via the Financial District. IT is a two-way roadway between Government Center and Post Office Square where it becomes one-way southbound to Atlantic Avenue. North of State Street it provides two lanes of travel in each direction with parking or reserved lanes. South of State Street it is marked for two lanes in each direction. However, standing and/or delivery vehicles are found in the second lane on many occasions.

- Surface Artery - a major north/south artery east of the site running under the elevated Central Artery. It is a divided roadway providing two travel lanes and one parking lane in each direction.

- State Street - a major connector between the Surface Artery and the northern CBD/southern Government Center area. This 32 foot, one-way westbound roadway is intended to carry two moving lanes adjacent to the site with a loading area provided on the northerly side.

Exhibit IV A-2 STUDY AREA CIRCULATION



The key to traffic operation in the corridor is the Congress Street/State Street intersection, one block west of the State Street/Kilby Street intersection. While previous reports have indicated the intersection should function at an adequate level of service, the high degree of pedestrian, standing and loading/unloading activities east and west of the intersection leads to considerable queuing and delay on the State Street approach. These activities are compounded by the exclusive pedestrian crossing phase, the time for which, when actuated by pushbutton, is taken wholly from the State Street approach green time. This queuing, which at times extends easterly to Broad Street, is also affected by vehicles exiting from Kilby Street, desiring to turn right to Congress Street northbound, blocking the left lane. This blockage reduces the effect of the two-lane State Street approach to Congress Street.

- Broad Street - a low-use roadway which serves a series of retail, restaurant and office uses with some warehousing between the Surface Artery and State Street. The roadway, which is generally 50 feet in width (although the width varies south of the site), carries one moving lane in each direction with parking permitted on both sides. The roadway has the right-of-way at all intersecting side streets except at State Street (STOP sign controlled) and at the Surface Artery (traffic signal control).

- Kilby Street - This low-volume, 28-foot wide roadway adjacent to the site, extends from Milk Street to State Street. Kilby Street is one-way northbound between Water Street (Liberty Square) and State Street, but is two-way between Water Street and Milk Street. South of Milk Street it is aligned with Oliver Street which provides a two-way connection to Franklin Street. South of Franklin Street, the roadway is one-way northbound from High Street. The roadway provides the only entrance and exit to/from the Kilby Street garage and is the primary means of egress from the One Post Office Square garage (on Oliver Street) to the north. It also serves as a "jug-handle" for the State Street/Congress Street intersection. At that intersection, left turns are prohibited northbound on Congress Street to State Street. Consequently, all vehicles desiring to complete that maneuver use Water Street to Kilby

Street to State Street. Operations on Kilby Street are controlled by State Street. As previously described, operations at the State Street/Congress Street intersection result in queuing across Kilby Street, making it an undesirable route to use.

- Doane Street - this low-volume, 20-foot roadway serves less than 500 vehicles per day. As of July 1, 1985, the roadway was discontinued. It is now a private way under control of the Project Proponent. Primary use occurs during the evening peak period when vehicles leaving the Kilby Street Garage use the one-way (eastbound) roadway to reach Broad Street. During the evening peak period, half the vehicles using the roadway are exiting from the garage.

- Exchange Place is a 24-foot roadway connecting Kilby Street and Congress Street. It carries a relatively low volume of traffic and its primary function is to serve parking and loading requirements of the recently completed 53 State Street development (Exchange Place).

- Water Street is a 25-foot local roadway serving circulating traffic. It is one-way westbound between Broad Street and Kilby Street and one-way eastbound between Congress Street (extending westerly to Washington Street) and Kilby Street. Its primary use during the morning peak is to provide access to the Kilby Street garage from east and west of the corridor.

Existing Traffic Volumes

Estimates of existing peak hour volumes are shown in Exhibits IV-A-3 and IV-A-4. These volumes were obtained from a variety of sources, including mid-week counts taken in May, 1985 and base network volumes taken from the International Place EIR. Because the International Place volumes represented 1984 conditions, they were adjusted upward by 4.5 percent to reflect 1985 conditions. This factor represents a proportionate share of the 1990 Build volumes from the International Place analysis. The use of this factor represents a conservative approach, as it most likely overstates the proportion of projected 1990 development which is currently occupied. Adjustments were also made to the volumes at the intersection of State street and Surface

Exhibit IV A-3

EXISTING AM PEAK HOUR TRAFFIC VOLUMES

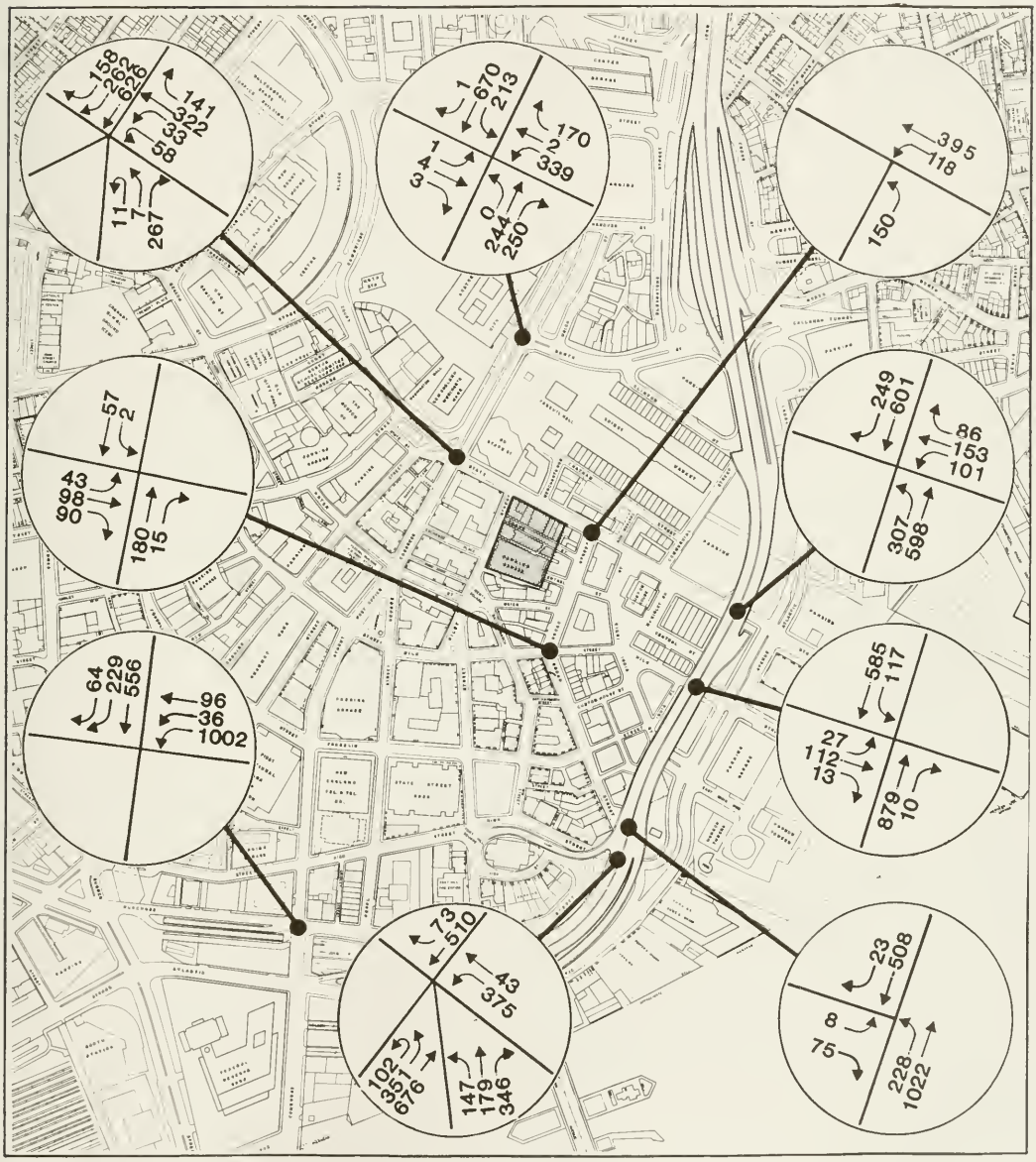
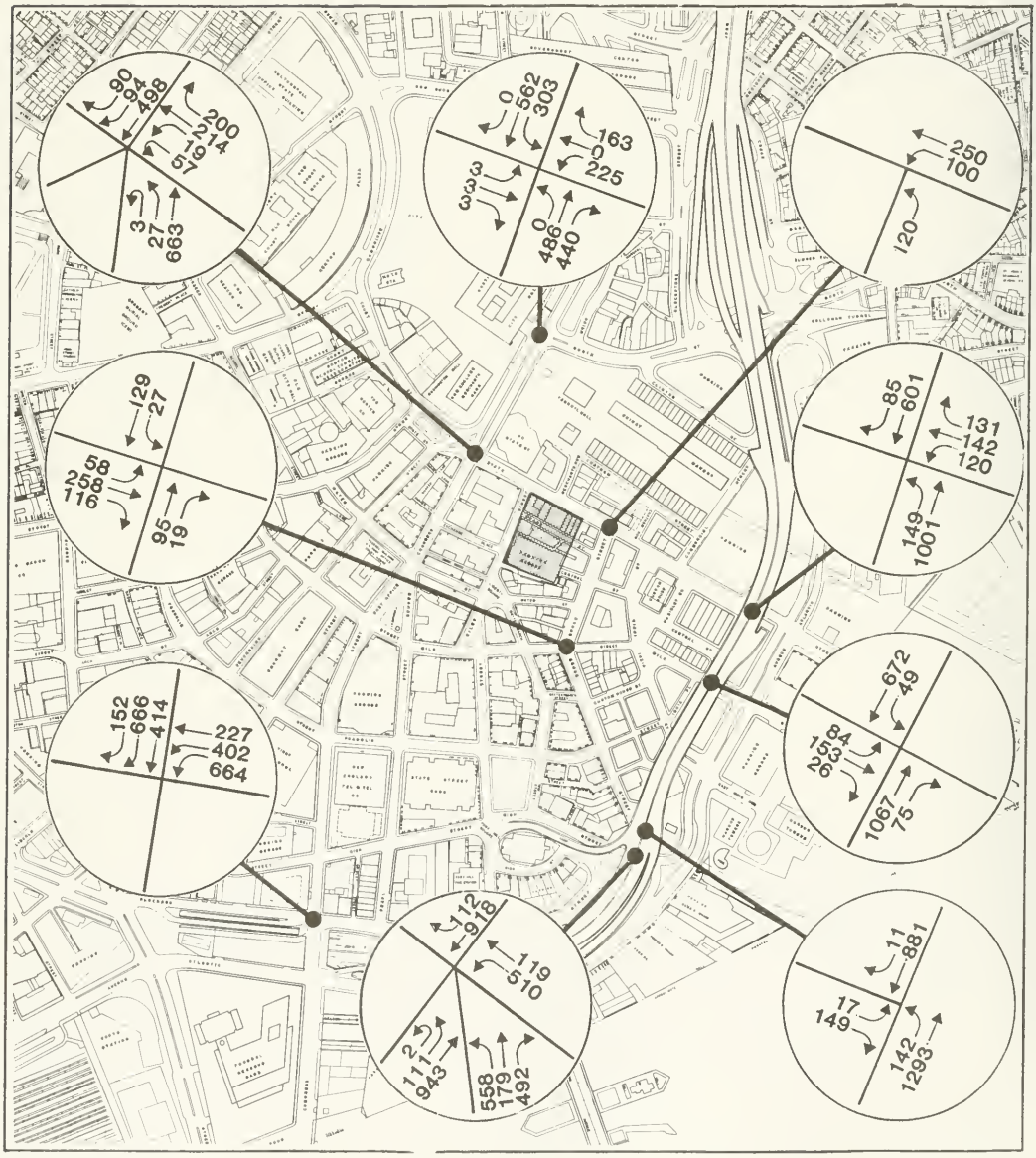


Exhibit IV A-4

EXISTING PM PEAK HOUR TRAFFIC VOLUMES



Artery to reflect the impact of the recent permanent closing of Commercial Street in front of Marketplace Center.

Pedestrian Volumes

Pedestrian crossing counts were conducted in the project area during the summer of 1985. These have been summarized for morning, noon and evening peak hours in Exhibits IV-A-5, IV-A-6 and IV-A-7, respectively.

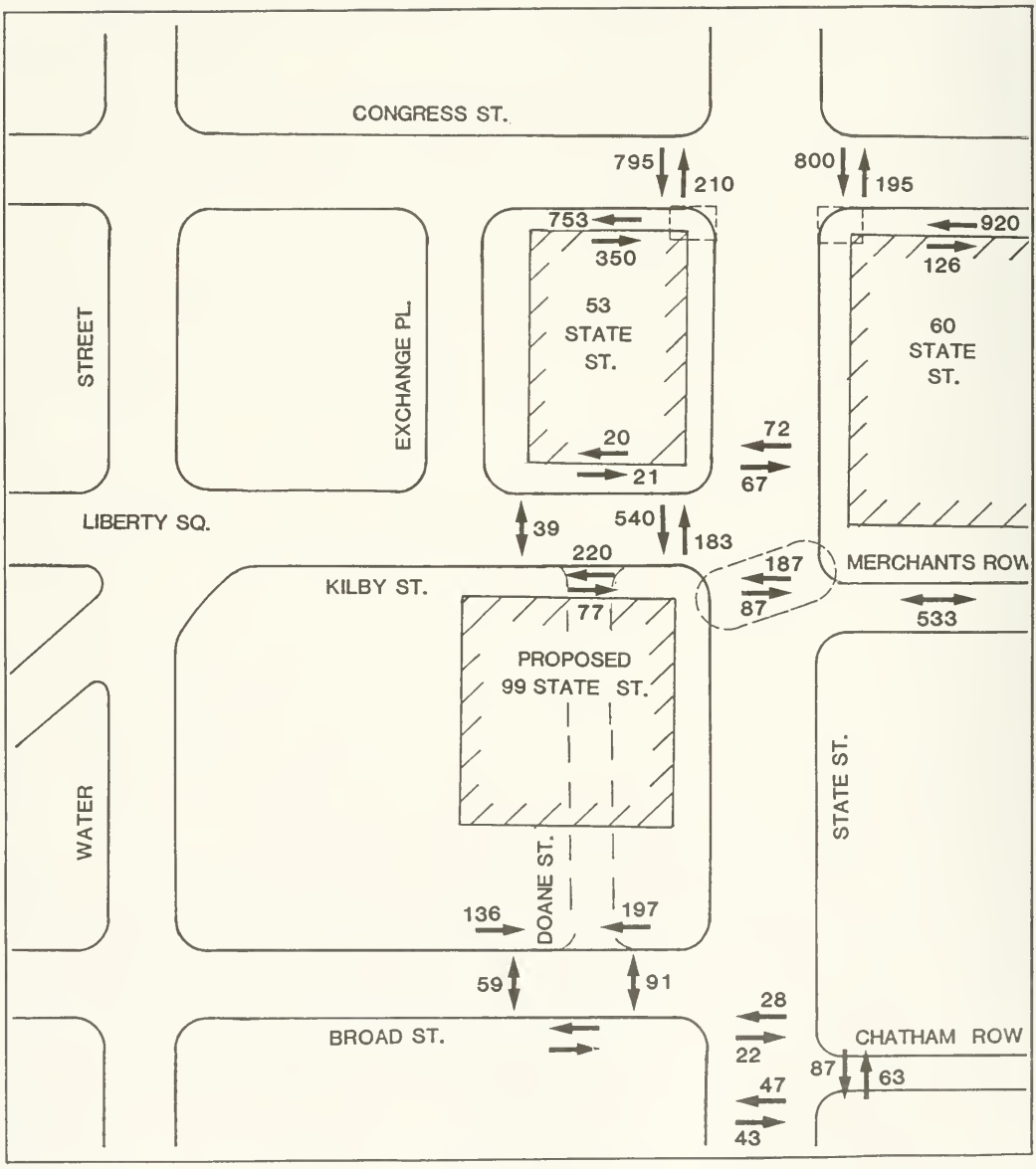
Public Transportation System

The proposed project is well served by public transportation. Exhibit IV-A-8 illustrates the major components of the system and their distances from the site. Because of the proximity of the site to the rapid transit system, a significant emphasis has been on system capacity and ridership.

Rapid Transit

Direct access to all four rapid transit lines is within walking distance of the site. The nearest station is State Street just a few blocks to the west. It provides access to both the Orange and Blue Lines. A few blocks further northwest is Government Center station which serves both the Green and Blue Lines. An additional Blue Line station is located east of the site at the corner of State Street and Atlantic Avenue (Aquarium). Access to the Red Line is available directly via the Washington Street station a few blocks west of the site, or at South Station, which is nearly a half mile from the site. Alternatively, the Red Line can be reached via a transfer from the Orange Line at Washington Street or from the Green Line at Park Street.

Currently, trains running through South Station on the Red Line can accommodate almost 18,000 passengers under normal conditions and over 23,000 passengers under crush conditions during the peak hour. The Green Line can accommodate 9,600 and 12,400 passengers respectively, under normal and crush loadings, on all lines through Government Center. The greater Red Line capacity at South Station is due to the use of higher capacity cars at greater frequencies. Trains through the State Street station on the Orange Line are capable of carrying almost 10,000 passengers under normal loadings and


CONGRESS ST.
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STREET
EXCHANGE PL.
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21
72
67
LIBERTY SQ.
39
540
183
220
187
87
MERCHANTS ROW
KILBY ST.
77
533
PROPOSED
99 STATE ST.
STATE ST.
WATER
DOANE ST.
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91
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BROAD ST.
CHATHAM ROW
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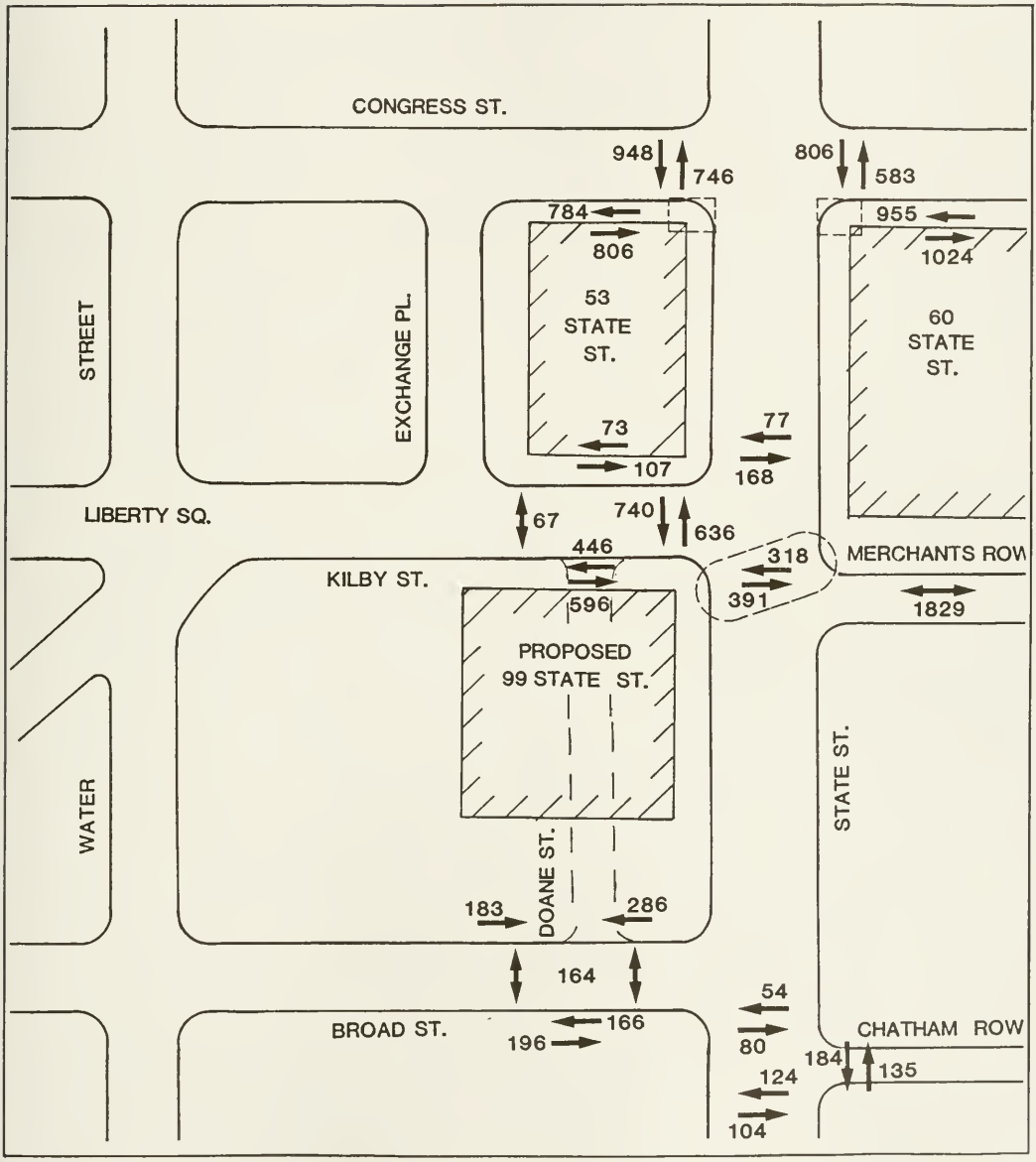
47
43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EXCHANGE PL.
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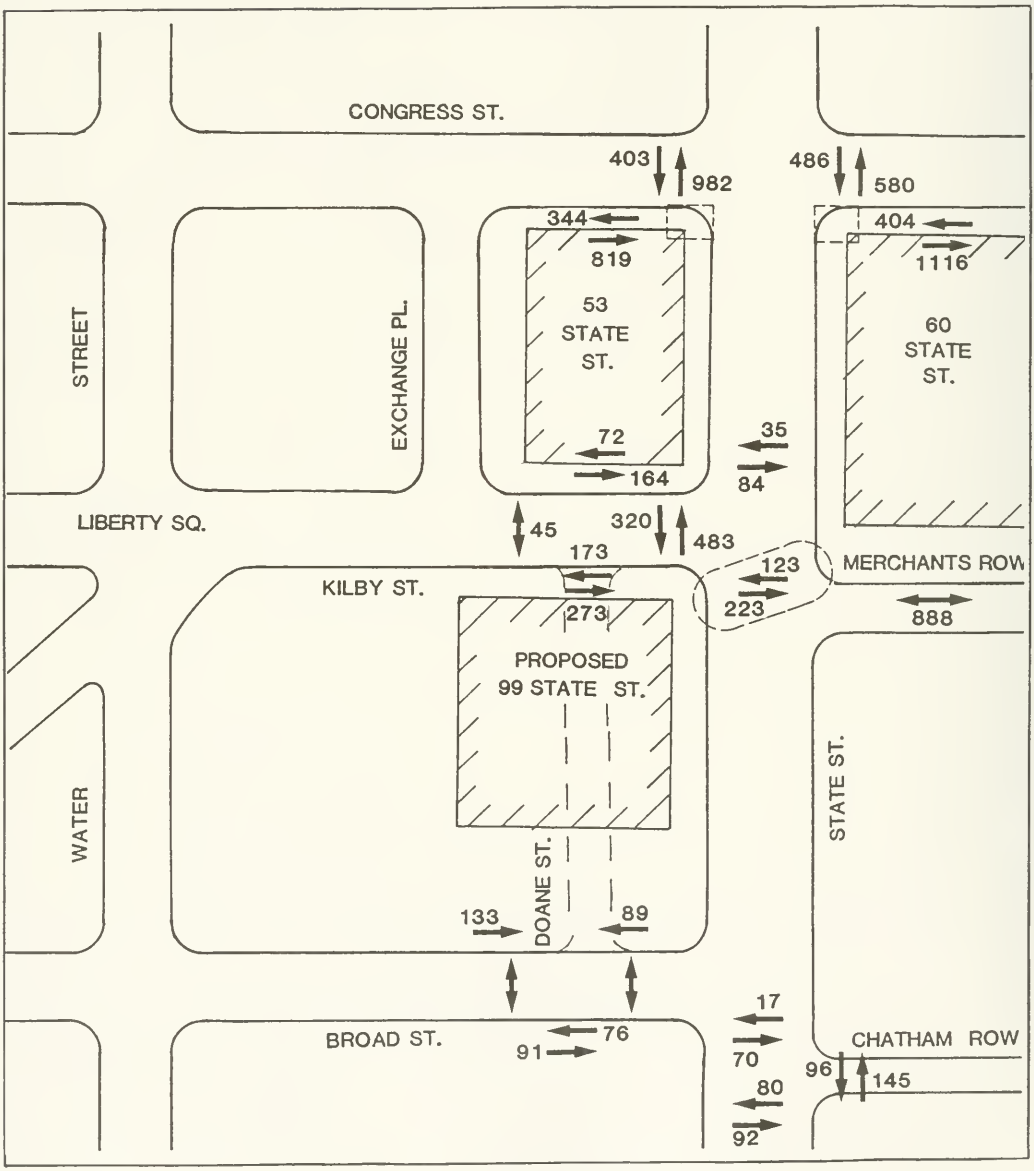
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76
CHATHAM ROW
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145
80
92

PEDESTRIAN DISTANCES BETWEEN SITE AND TRANSIT STATIONS

12,000 under crush loadings, while the Blue Line can handle 7,000 and 9,000 riders through this station. Table IV-A-1 shows the various lines and their evening peak hour peak direction capacities. Table IV-A-2 provides data on current ridership during peak loads at peak stations. Note that both Tables IV-A-1 and IV-A-2 assume that all rolling stock assigned to the various lines is operational and that scheduled headways are maintained.

Bus Service

The area is well served by commuter bus service, with MBTA Express service provided to the Haymarket area and Financial District from the north and west. Additional commuter bus service by private carriers is provided to South Station and the Haymarket area. The resultant of these lines is full area coverage by bus within one-half mile of the site. The drop-off points are provided with easy access to MBTA rapid transit lines which further enhance service to the site.

These lines are well used and it is the MBTA's policy to encourage continued use by minimizing standees. Consequently, the MBTA will add buses as demand warrants.

Parking

Parking within the Financial and Quincy Market areas is limited. The major facilities within the project area, other than the Kilby Street Garage include Post Office Square (950 spaces), Government Center (1,865 spaces), Harbor Towers (1,400 spaces), One Post Office Square (400 spaces) and the Quincy Market Garage. With the recent loss of several major facilities to the south (Fort Hill Square and High Street) parking demand within the southerly fringes of the area has increased to the point at which major facilities are near capacity.

Kilby Street Garage Operation

The 99 State Street parcel currently provides parking for up to 725 vehicles between a surface parking facility on the corner of State and Kilby Streets (25 spaces) and the 700-space Kilby Street garage. The practical capacity of parking garage capacity is limited

TABLE IV-A-1
RAPID TRANSIT LINE CAPACITY
PEAK HOUR PEAK DIRECTION

Line/Segment	Cars/ Train	Headway (Minutes)	No. of Trains	Car Capacity* Normal	Car Capacity* Crush	Line Capacity Normal	Line Capacity Crush
Red Line**							
Alewife-Ashmont	4	8.5	8	187	244	5,984	7,808
Braintree-Davis	4	8.5	8	187	244	5,984	7,808
Quincy-Park	4	8.5	8	187	244	5,984	7,808
Total (through Washington)	4	2.8	24	187	244	17592	23424
Green Line							
N. Sta.-Cleveland Cir.	2	7.5	9	165	214	2,970	3,852
Government Ctr.-BC	2	7	9	165	214	2,970	3,852
Lechmere-Riverside	2	6	11	165	214	3,630	4,708
Total (through Government Ctr.)	2	2.3	29	165	214	9,570	12412
Orange Line***							
Oak Grove-Forest Hills	4	4	16	155	197	9,920	12608
Blue Line							
Bowdoin-Wonderland	4	4	16	110	139	7,040	8,896

* Normal capacity includes seating capacity plus standees at 2.5 square feet of space per person. Crush capacity is based on 1.75 square feet per standee.

** Construction scheduled for completion in 1987-1988 will allow the capability of expanding trains to 6 cars.

*** Construction to be completed in 1987 will allow the capability of expanding trains to 6 cars

TABLE IV-A-2
EXISTING RAPID TRANSIT USE

Line/Segment	Peak Station	Existing Use	Line Capacity at Peak	
			Normal	Crush
Red Line/North Ashmont-Alewife Braintree-Davis	Charles	6,440	11,968	15,616
Red Line/South Alewife-Ashmont Davis-Braintree Park-Quincy	Andrew	12,120	17,592	23,424
Green Line/West Cleveland Cir/-N. Sta. Boston Coll.-Gov. Ctr. Lechmore-Riverside	Arlington	7,040	9,570*	12,412*
Green Line/East Riverside-Lechmere	Science Park	1,100	3,630	4,708
Orange Line/North Forest Hills-Oak Grove	North Station	10,270	9,920	12,608
Orange Line/South Oak Grove-Forest Hills**	Essex	7,080	9,920	12,608
Blue Line/North Bowdoin-Wonderland	Aquarium	6,120	7,040	8,896

* Not shown is additional capacity available via Arborway-Park line which passes through Arlington Station.

** No data available for Washington/State link.

to approximately 450 spaces because of elevator capacity and the arrangement of spaces within the structure.

Access to the current garage is provided via Kilby Place, an alleyway intersecting Kilby Street near Exchange Place. The lack of elevator capacity is highly evident during the morning peak periods when vehicles accessing the garage are queued through Liberty Square and on both Water Street approaches to the Square. This queuing effectively eliminates vehicle access to both Exchange Place and State Street via Kilby Street.

PROBABLE PROJECT IMPACTS

Site Access Plan

Requirements for pedestrian access to the site, open space within the structure, and traffic conditions on service roadways have led to definition of a site access and parking plan that relies heavily on Broad Street. The major benefits of this plan include:

1) A reduction in vehicles on Kilby Street (by up to 30 percent during the evening peak hour) with the associated improvement to operations at the Kilby Street/State Street and Congress Street/State Street intersections;

2) Better access to and egress from the site via the underutilized Broad Street corridor. Vehicles have the option to proceed in all directions from the garage exit because Broad Street is a two-way facility;

3) Isolation of parking trips from loading and delivery vehicles which will access the site from Kilby Street;

4) Isolation of parking trips from the major pedestrian entrances located on Kilby Street opposite Exchange Place and from State Street;

5) The use of Doane Street approaching Broad Street as a ramp to the structure does not require the installation of a new curb cut;

6) Elimination of all parking access from Kilby Street eliminates the need for any breaks in the sidewalk between Exchange Place and State Street, an area of relatively high pedestrian activity.

Truck access and general loading and unloading activity will be via Kilby Place. This roadway currently serves as the entrance to the Kilby Street Garage from Kilby Street. A minimum of five loading docks are to be provided in a manner which will permit truck access without backing out of or into Kilby Street.

To improve access to and from the loading area, a recommendation of this review is a change to a two-way Kilby Street from Exchange Place to Liberty Square. From Liberty Square, vehicles are permitted to access Milk Street, Batterymarch Street and Oliver Street to leave the site. This proposed change, which involves less than 100 feet of Kilby Street, will serve to further reduce truck movement into the Kilby Street/ State Street intersection and consequently the State Street/Congress Street intersection.

An additional traffic flow revision is recommended on Water Street between Liberty Square and Broad Street. This section of roadway is now one-way westbound with a primary function of providing access to the Kilby Street garage from Broad Street. The balance of the Water Street corridor west of Liberty Square (including Beacon, School and Washington Streets) is one-way eastbound providing a connection from the Beacon Hill area to Liberty Square where vehicles turn left to Doane Street to reach Broad Street. With the elimination of the need for access to the Kilby Street garage, the reversal of Water Street to provide eastbound operation would have several benefits. Initially, an alternate route to Broad Street from Beacon Hill will be provided paralleling Milk Street. Secondly, traffic flow will improve within the Liberty Square area with one approach eliminated.

Daily Trip Generation

In order to assess the impact of the project on the transportation system in the site area, travel demand by type of use and user has been estimated. The procedures used in estimating these trips consisted of calculating person-trips per 1,000 square feet of floor space. Trip

rates and modal splits have been categorized as office vs. retail and work vs. non-work. Rates used in the calculations are identical to those used in recently completed EIRs for the downtown financial district and International Place.

The development plan calls for 685,000 square feet of office space and 15,000 square feet of retail space. Tables IV-A-3 and IV-A-4 summarize trip rates and modal splits assumed in the analysis and the resultant person-trips based on the proposed development plan.

TABLE IV-A-3
DAILY PERSON-TRIPS

User	Office			Retail Use		
	In	Out	Total	In	Out	Total
Generation Rates*						
Worker	4.40	4.40	8.80	2.75	2.75	5.50
Non-Worker	2.35	2.35	4.70	16.40	16.40	32.80
Total	6.75	6.75	13.50	19.15	19.15	38.30
Generated Trips**						
Worker	3,014	3,014	6,028	41	41	83
Non-Worker	1,610	1,610	3,220	246	246	492
Total	4,624	4,624	9,248	287	287	575

* person trips per 1,000 square feet
** total trips per day

Table IV-A-5 summarizes anticipated vehicle occupancy rates for those trips arriving by auto. These rates were based primarily on actual surveys of area employees.

TABLE IV-A-4
MODE SPLIT

User	Office Use			Retail Use		
	Auto	Transit	Walk	Auto	Transit	Walk
Percentages						
Worker	30*	70	0	30	70	0
Non-Worker	27.5*	57.5	15	27.5	32.5	40
Total Person-Trips						
Worker	1,808	4,220	0	24	58	0
Non-Worker	886	1,852	484	136	160	196

* The 30 percent factor represents a conservative analysis based on data contained within the December, 1983 Parking in Central Boston: Meeting the Access Needs of a Growing Downtown. Data contained within the report referenced a 1980 study of arrivals by auto to specific buildings downtown. The three major generators in the area (89 State Street, 60 State Street and 53 State Street) had auto arrival rates of 23.5 percent, 20.7 percent and 19.4 percent, respectively.

TABLE IV-A-5
VEHICLE OCCUPANCY FACTORS

Trip Type	Use	
	Office	Retail
Work	1.8	1.4
Non-Work	1.4	1.9

Applying the occupancy rates given in Table IV-A-5 to the auto arrivals projected in Table IV-A-4 results in a total of 1,726 vehicle-trips (Table IV-A-6). These are distributed equally to inbound and outbound trips with 863 each way. The 1,726 vehicle-trips include employee related trips, visitors, taxis, and delivery vehicles.

Refinement of the 1,726 trips to estimate taxi and delivery use suggests 100 taxi-related trips (3 percent of office non-employee arrivals as described in the Market Place Center EIR) and 175 delivery-related trips (0.25 trips per 1,000 square feet).

TABLE IV-A-6
DAILY VEHICLE TRIPS

	Use		
Trip Type	Office	Retail	Total
Work	1,004	17	1,021
Non-Work	633	72	705
Total	1,637	89	1,726

The 1,726 daily vehicle-trips represent total trips attracted by the development. They have not been reduced by existing traffic to the site to calculate net additional daily traffic. However, the net additional peak hour traffic has been calculated and is discussed in the following section.

Peak Hour Trip Generation

Of greater concern than the total daily trips is the number of trips occurring during the peak commuter hours. It is these peak periods which are used to evaluate the performance of the transportation system. The peak hour factors shown in Table IV-A-7 were multiplied by one-half (to reflect directional travel) of the daily trips in Tables IV-A-4 and IV-A-6 to obtain the results shown in Table IV-A-8. A total of 309 vehicle-trips are projected for the morning peak hour, while 317 trips are projected for the evening peak.

TABLE IV-A-7
PERCENTAGES OF DAILY TRIPS
DURING PEAK HOURS BY
TYPE AND DIRECTION*

	Work		Non-Work	
	AM	PM	AM	PM
Office				
Arrivals	55%	0%	10%	0%
Departures	0%	55%	0%	10%
Retail				
Arrivals	10%	10%	0%	5%
Departures	0%	20%	0%	10%

* From International Place EIR

TABLE IV-A-8
PROJECT PEAK HOUR TRIPS BY MODE

	AM			PM		
	Auto*	Transit**	Walk**	Auto*	Transit**	Walk**
Office						
Work	276	1,161	0	276	1,161	0
Non-Work	32	93	24	32	93	24
Retail						
Work	1	3	0	3	9	0
Non-Work	0	0	0	6	24	15
Total	309	1,257	24	317	1,287	39

* Vehicle trips
** Person trips

Net Additional Peak Hour Vehicle-Trips

The peak hour trips generated above represent the total number of trips generated by the site when it is fully developed as proposed. However, the existing development on the site is currently generating trips which are

part of the existing trips on the area's street and transit systems. In order to assess the net impact of the proposed development, the existing trips associated with current uses were subtracted from the total trips expected to be generated by the proposed development. The difference represents the net additional traffic placed on the applicable system as a result of the redevelopment of the site.

Existing development on the site consists of 140,000 square feet of office and retail space, a 700 space parking garage and a 25 space surface parking lot. Based on the generation rates, modal split, vehicle occupancy factors, and peak hour factors used above, the existing commercial development is estimated to generate 57 vehicle-trips in the morning peak hour and 65 trips in the evening peak hour. The net increase is therefore 252 trips in the morning peak hour and 252 trips in the evening peak hour.

Turning movement counts taken in May 1985 at the Kilby Street garage indicate that approximately 160 vehicles enter in the morning peak hour and approximately 115 exit in the evening peak hour. Because these volumes are in excess of those estimated to be generated by the existing office and retail uses, there appears to be demand for space in the garage associated with other uses in the area. This demand can be expected to be continued to be placed on the new garage. Therefore, these trips will continue to be a part of the Base condition. A similar conclusion can be reached with regard to any peak hour trips associated with the existing 25 space lot.

The use of a net addition of 252 trips in the morning and evening peak hours represents a conservative approach to estimating the impact of the development on the surrounding street system. This is because it is assumed that all new trips are attracted directly to the site and will be accommodated in the garage. No adjustment is made for any trips which may be diverted to other garages or parking areas away from the site. Some degree of diversion to other facilities such as the Harbor Towers, Post Office Square, or Government Center garages, can be expected.

Net Additional Peak Hour Transit Trips

The existing 140,000 square feet generates approximately 250 morning peak hour person-trips via transit when the factors of Tables IV-A-3, IV-A-4 and IV-A-7 applied. The current evening peak hour generation total also equals about 250 person-trips.

Table IV-A-9 provides a summary of the net increase in site generated traffic resulting from the 99 State Street project.

TABLE IV-A-9
NEW SITE GENERATED TRIPS

	Morning Peak Hour			Evening Peak Hour		
	Auto	Transit	Walk	Auto	Transit	Walk
99 State St.	309	1,257	24	317	1,287	39
Existing	57	250	5	65	250	5
Net New Trips	252	1,007	19	252	1,037	34

Trip Distribution and Assignment

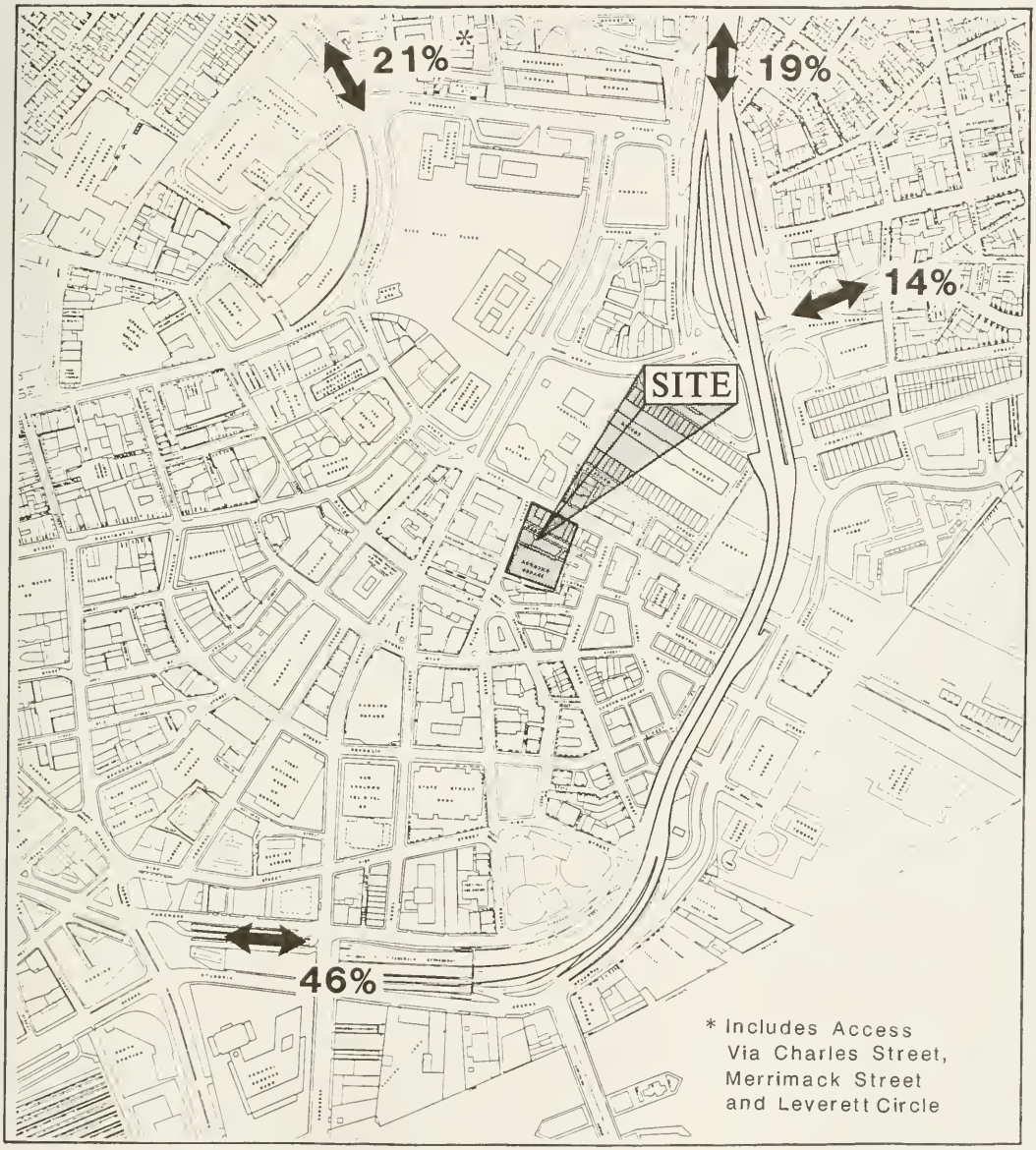
The net additional vehicle-trips from the proposed development were distributed to the transportation system according to the trip distribution pattern shown in Exhibit IV-A-9. This is the same pattern that was established in other major EIRs. Assignment of these trips to the local street system in the vicinity of the site was a function of the access to the proposed garage, the existing pattern of one-way streets in the vicinity and previously identified revisions to the circulation system of the site and the location of Central Artery ramps. The location of the new garage access to Broad Street via Doane Street results in a reassignment of existing garage trips from Kilby Street to Broad Street.

Background Traffic Growth

In order to assess future conditions, it is not only necessary to project development-related traffic

Exhibit IV A-9

TRIP DISTRIBUTION MAP



increases, but also to project increases in background traffic. Growth in background traffic is a function of other development activity expected within the area. This growth can be projected by the application of a generalized growth factor or by the assessment of specific development proposals. For this analysis, the projection of background or No-Build traffic (i.e., future traffic without the development proposal) was based on previous studies which used a combination of these approaches.

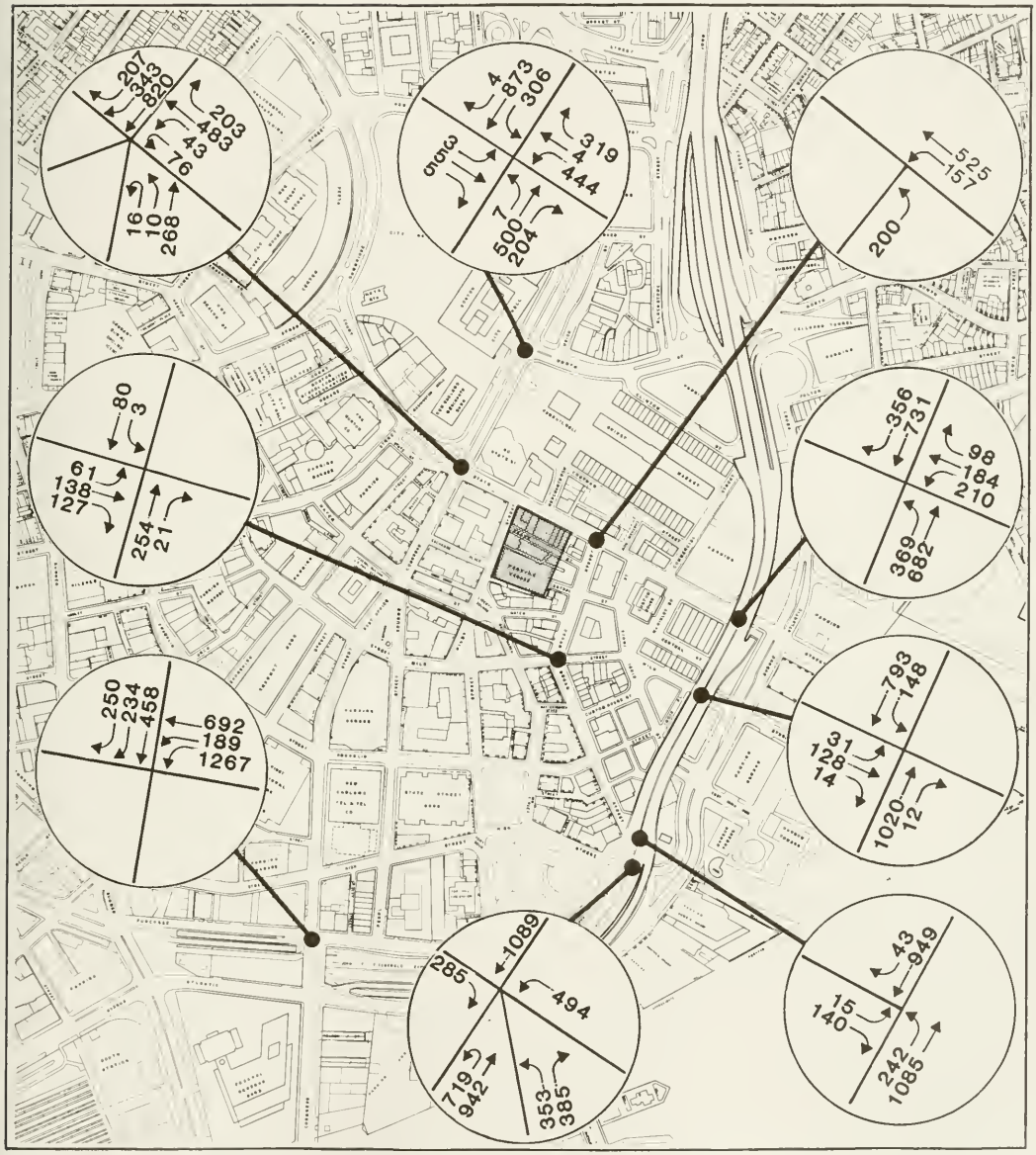
The proposed 99 State Street development is expected to be completed in 1989. A 1990 base has been used as the design year for other major projects in the City, including International Place. Consequently, this analysis builds upon the 1990 Build volumes from the International Place EIR for those intersections included in both analyses. The 1990 design year provides for development and occupancy of over 7,000,000 square feet of office and retail space. Approximately one million square feet are in South Boston with the balance within the Downtown/Financial District.

Projection of 1990 No-Build volumes for intersections not analyzed in previous studies were developed by balancing and adjusting volumes at the newly analyzed intersections to the volumes at the previously analyzed intersections. The resulting 1990 No-Build peak hour volumes are shown in Exhibits IV-A-10 and IV-A-11. The net additional traffic from the proposed 99 State Street development was added to these 1990 No-Build volumes to obtain the 1990 Build volumes shown in Exhibits IV-A-12 and IV-A-13.

As noted earlier, the 1990 No-Build and Build networks have been adjusted to account for the recent permanent closure of Commercial Street. In addition, the 1990 networks assume the relocation of the High Street Central Artery off-ramp to Purchase Street, as outlined in the International Place EIR. Finally, the 1990 networks do not include the depression of the Central Artery, as that project would not be completed until sometime after 1990.

Exhibit IV A-10

1990 NO BUILD AM PEAK HOUR TRAFFIC VOLUMES



1990 NO BUILD PM PEAK HOUR TRAFFIC VOLUMES

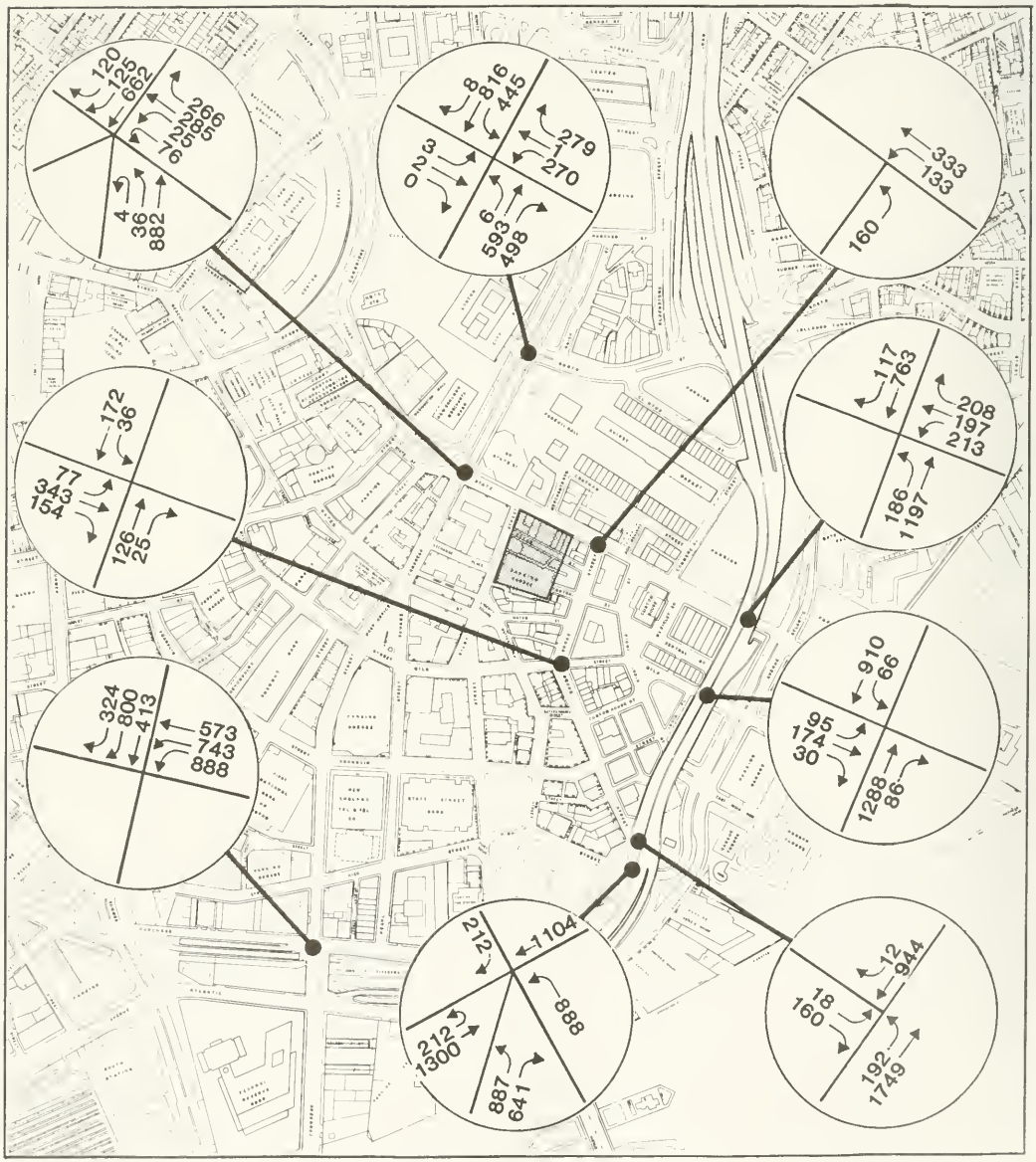


Exhibit IV A-12

1990 BUILD AM PEAK HOUR TRAFFIC VOLUMES

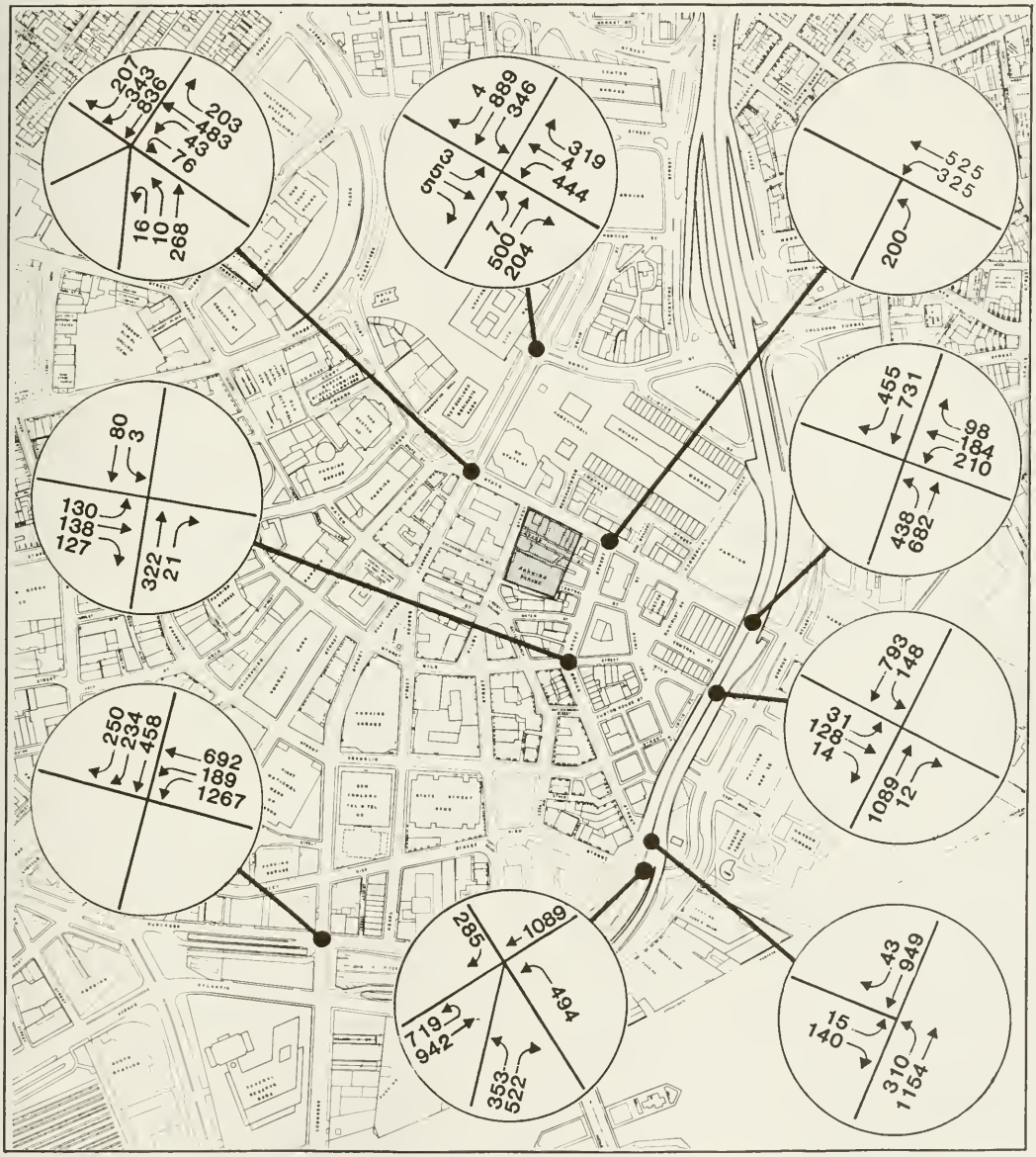
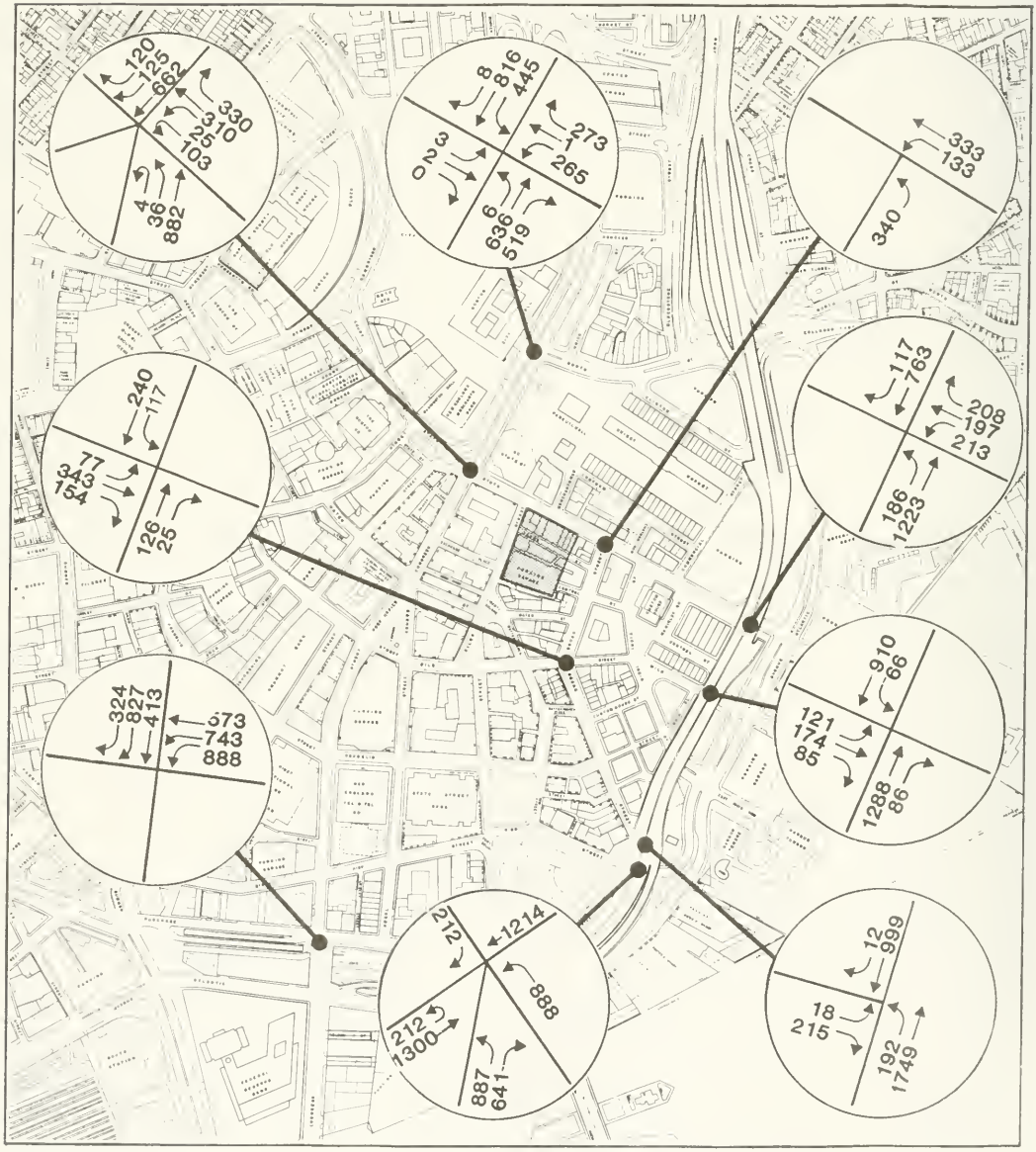


Exhibit IV A-13 1990 BUILD PM PEAK HOUR TRAFFIC VOLUMES



Intersection Analysis

Traffic Operations Measures

Level of service (LOS) is a term used to denote the operating conditions on a roadway and is qualitatively measured as the effect of speed, delay, freedom to maneuver and safety. At Level of Service "A", the intersection operates at free-flow conditions. Typically, the intersection approach appears quite open and turning movements are made easily. Seldom, if ever, does a driver have to wait through more than one red signal indication.

Capacity of the intersection occurs at Level of Service "E" and is characterized by consistent backups or queues of vehicles waiting to pass through the intersection. Capacity represents the maximum number of vehicles that can be processed during a given time frame. At capacity conditions, vehicles will always be waiting on approach roadways to use signal green time. In this situation, some motorists may experience significant delays. There are many intersections in the Boston Metropolitan area which operate at capacity levels during peak demand periods.

The analysis of signalized intersections is based on the sum of critical volumes from each intersection approach and the ratio of this volume to capacity. The capacity is equal to the maximum sum of critical volumes associated with Level of Service "E". Basic level of service criteria are shown in Table IV-A-10. For each individual intersection, these critical-volume criteria were reduced by the percent of cycle time allocated to exclusive pedestrian phases or by the estimated percent of green time lost by pedestrian interference (i.e., pedestrians walking against the "Don't Walk" signal or pedestrians caught in the crosswalk during the change to green).

In capacity calculations for unsignalized intersections, the assumption is made that major street movement is not effected by minor street movement and that the capacity is a function of turn within the intersection and gaps in the through traffic stream. The difference between available capacity and existing demand is defined as reserve capacity and is used as the criterion for

TABLE IV-A-10
LEVEL OF SERVICE CRITERIA
FOR SIGNALIZED INTERSECTIONS*

Service	Maximum Sum of Critical Volumes			Typical Volume/ Capacity Ratio
	Two Phase	Three Phase	Four or More Phases	
A	900	855	825	0.00-0.60
B	1,050	1,000	965	0.61-0.70
C	1,200	1,140	1,100	0.71-0.80
D	1,350	1,275	1,225	0.81-0.90
E	1,500	1,425	1,375	0.91-1.00
F	- - - Not Applicable - - -			Varies

* Transportation Research Board, Transportation Research Circular Number 212, Interim Materials on Highway Capacity, Washington, D.C., January, 1980 (Planning Criteria).

determining level of service. Table IV-A-11 summarizes the relationship between level of service, reserve capacity and expected traffic delay.

TABLE IV-A-11
LEVEL OF SERVICE CRITERIA
FOR UNSIGNALIZED INTERSECTIONS*

Reserve Capacity	Level of Service	Expected Traffic Delay
400 or more	A	Little or no delay
300 to 399	B	Short traffic delays
200 to 299	C	Average traffic delays
100 to 199	D	Long traffic delays
0 to 99	E	Very long traffic delays
Less than 0	E	Failure-extreme congestion
(Any Value)	F	Intersection blocked by external causes

* Transportation Research Board, Transportation Research Circular Number 281, Proposed Chapters for the 1985 Highway Capacity Manual, Washington, D.C., June 1984.

Capacity Analysis

All the intersections studied, except for Broad street at State Street and Broad Street at Milk Street, were analyzed using the signalized intersection analysis procedure described above. The two Broad Street intersections were analyzed using the unsignalized intersection technique. Table IV-A-12 summarizes the results of the capacity analyses for all intersections for existing, No-Build and Build conditions.

Currently, two of the signalized intersections (Congress Street/Purchase Street and High Street/Surface Artery) operate at LOS "E" in the evening peak hour. The only other intersection currently operating below LOS "C" is Congress Street and North Street, which is at LOS "D".

TABLE IV-A-12
INTERSECTION ANALYSIS

Location	Existing V/C	Existing LOS	1990 No-Build V/C	1990 No-Build LOS	1990 Build V/C	1990 Build LOS
Congress St./ Purchase St.						
AM	0.80	C	0.95	E	0.95	E
PM	0.94	E	1.19	E	1.20	E
Congress St./ State St.						
AM	0.62	B*	0.85	D	0.86	D
PM	0.54	A*	0.71	C	0.77	C
Congress St./ North St.						
AM	0.75	C	0.87	D	0.90	D/E
PM	0.84	D	1.07	E	1.08	E
State St./ Surface Artery						
AM	0.52	A	0.66	B	0.77	C
PM	0.66	B	0.83	D	0.84	D
Milk St./ Surface Artery						
AM	0.57	A	0.77	C	0.77	C
PM	0.69	B	0.83	D	0.89	D
Broad St./ Surface Artery						
AM	0.40	A	0.62	B	0.66	B
PM	0.52	A	0.58	A	0.64	B
High St./ Surface Artery						
AM	0.73	C	1.11	E	1.11	E
PM	0.90	D/E	1.21	E	1.21	E
State St./ Broad St.**						
AM	505	A	317	B	150	D
PM	486	A	370	B	190	D
Broad St./ Milk St.**						
AM	645	A	554	A	439	A
PM	621	A	540	A	494	A

* See text for further explanation of actual operating conditions.

** Intersections are unsignalized. Analysis presents reserve capacity for the most critical movement.

It should be noted that the levels of service calculated for the State Street/Congress Street intersection in Table IV-A-12 are somewhat better than observed operating conditions at times. Four reasons for this have been identified.

1. Downstream constraints -- Constraints away from the intersection on both Congress and State Streets at times block the intersection.

2. Standing vehicles/illegal parking -- Capacity of the approach (or departure) is reduced by standing, parked or double-parked vehicles on the State Street and Congress Street northbound approaches and the Congress Street southbound departure.

3. Pedestrian movement -- A high degree of pedestrian movement occurs throughout the signal cycle obstructing vehicle movement.

4. Exclusive pedestrian crossing phase -- The time given to the exclusive crossing phase is taken solely from State Street "green" time, significantly reducing the time available for vehicle movement.

The capacity analyses for the State Street/Congress Street intersection were based on the provision of two approach lanes on State Street and on northbound Congress Street. The reduction of capacity for pedestrians was based on the share of the signal cycle allocated to the exclusive pedestrian phase. To the extent that the factors discussed above reduce the effective number of approach lanes or decrease capacity further because of pedestrian interference during green time, actual operating conditions may fall below the levels of service which could be expected based on consideration of traffic volumes and intersection geometry alone.

The table illustrates the increase in volume-to-capacity ratios and decrease in level of service at all signalized intersections under "No-Build" conditions in 1990. The City is currently in the process of reviewing plans providing for the optimization of approximately 250 traffic signals in the Downtown area. The center of this program involves the installation of a computer to monitor traffic flow and select appropriate traffic signal phasing and timing based on demand. The computer portion of the program has been bid by the Massachusetts

Department of Public Works with the local intersection improvements expected to be bid within several months. This all leads to a completion date prior to occupancy of 99 State Street.

In addition to the overall optimization program, signals at the intersection of State Street and the Surface Artery will be upgraded. The upgrading will include provisions for pedestrian crossings and a leading green interval for northbound movement on the Surface Artery. This interval, similar to those at High Street and Clinton Street will provide an opportunity for left turns to be made from the northbound lanes without conflict from southbound through traffic.

These improvements are expected to have a major impact on improving operations at individual intersections and the system as a whole with the impact of reducing the noted volume/capacity ratios.

The addition of 99 State Street traffic to 1990 No-Build volumes results in only one location experiencing a significant change in level of service over the No-Build condition. In both peak hours, Broad Street traffic turning onto State Street would experience a decline to LOS "D" from the LOS "B" projected under 1990 No-Build conditions.

At the three intersections projected to operate at LOS "E" under 1990 No-Build volumes, the addition of 99 State Street will have little or no impact on volume-to-capacity ratios. In all but one case there would be no increase or an increase of only 0.01 in the V/C ratio. The one case with a larger increase would be at Congress Street/North Street during the morning peak hour, where the V/C ratio would increase from 0.87 to 0.90.

In terms of actual volume, the greatest impact would be at State Street and Broad Street. In the morning peak hour, 168 left turns onto Broad Street from State Street would be added. In the evening peak hour, 116 left turns out of Broad Street onto State Street are anticipated. Because State Street is one-way westbound, the evening volume entering State Street would be distributed through the Congress Street intersection. In the morning, the State Street volume would enter at the Surface Artery.

Of the intersections projected to operate at LOS "E", the largest development related volumes would occur at High Street/Surface Artery/Atlantic Ave. In the morning peak hour, 137 project related vehicles would use the intersection while in the evening, 110 project related vehicles would pass through the intersection.

Transit and Pedestrian Analysis

Rapid Transit

The proposed project is expected to generate approximately 1,280 outbound transit trips in the evening peak hour of which 1,050 will be new. Based on the 1982 Cordon Counts for Downtown Boston, 70 percent of transit trips are made by rapid transit. A total of 900 outbound rapid transit trips can be expected to be generated by the development, a net increase of 735. As described in the Traffic Impact section, a considerable level of background growth due to other area development is anticipated. The assignment of background and net project ridership increases are shown in Table IV-A-13. This assignment is based on each line's share of total rapid transit ridership in 1984.

TABLE IV-A-13
ASSIGNMENT OF RAPID TRANSIT TRIPS
GENERATED BY PROJECT AND BACKGROUND DEVELOPMENT
PM PEAK HOUR

Line/Direction	%	Background	Project	Total
Red/North	12	1,224	88	1,312
Red/South	23	2,346	169	2,515
Blue/North	12	1,224	88	1,312
Orange/North	20	2,040	147	2,187
Orange/South	14	1,428	103	1,531
Green/West	17	1,734	125	1,859
Green/East	2	204	15	219
Total	100	10,200	735	10,935

Passengers on the Green Line are expected to walk directly to Government Center to board, while most Blue Line and Orange Line passengers will load at State

Street. Red Line and commuter rail passengers are assumed to board the Orange Line at State Street to reach North Station directly or to transfer at Washington for the Red Line and South Station. Table IV-A-14 shows a conservative estimate of the number of loadings that would occur on the Orange Line southbound at State Street assuming all Red Line and commuter rail passengers board at this location. The Orange line would experience an increase in southbound loadings at this station of approximately 400 passengers from this project, in addition to 1,050 background project passengers for a total increase of approximately 1,450 passengers between State and Washington.

TABLE IV-A-14
RAPID TRANSIT LOADINGS - PM PEAK HOUR
ON THE ORANGE LINE STATE STREET - WASHINGTON

Line/Destination	Project	Background*	Total
Red/North	88	234	315
Red/South	169	449	618
Orange/South	103	273	376
Commuter Rail/South	37	98	135
Total	397	1,054	1,451

* Background figures include only passengers from Exchange Place and Market Place Center at this station.

Rapid Transit Improvements

A series of rapid transit improvements are underway with completion anticipated before 1990. These include a relocation of the Orange Line and the upgrading of Red Line service.

The Southwest Corridor Project involves the expansion of trains from four to six cars and the relocation of the Orange Line south of Essex Station. The segment involved is approximately 4.7 miles in length and includes eight new stations. Three of the eight stations will also be served by commuter rail services.

Red Line improvements include station modernization, acquisition of new cars, renovation of existing cars and track reconstruction. These improvements will allow the use of six-car trains resulting in a system capacity increase of up to 50 percent.

The Green Line is also scheduled for improvements to its vehicle fleet. New LRV's will be purchased which meet revised specifications, helping to alleviate recent equipment problems on the line and improving system performance.

The projected future volumes and capacities with improvements in place, are shown in Table IV-A-15. Under build conditions, the Orange Line will operate well under under normal capacity in both the north and south directions during the evening peak hour based upon six-car trains and current headways. The segment of the Orange Line between State Street and Washington which would carry Red Line and commuter rail passengers as well as Orange Line south passengers would also operate well under capacity. Under build conditions the Green Line too would operate under normal capacity. The Blue Line will exceed its normal capacity, but will operate below its crush capacity. With the planned expansion of the Red Line trains to six cars, this line too will operate under capacity. On most of the lines, less than 1.5 percent of projected line volumes would be project induced trips, although on the Orange Line between State Street and Washington, the Build volume represents a 3.2 percent increase over the No-Build volume. In general, background volume would generate approximately a 20 percent increase over existing volumes.

Express Bus

Almost one quarter of the project generated transit rider trips (275 evening peak hour) are expected to be by bus. Five express routes provide service between the Financial District and suburban areas along the Massachusetts Turnpike. Express bus service is also available from Haymarket to North Shore coastal communities. Local bus service is limited and has not been reviewed.

The expanse of the service coupled with the relatively low generation of new trips will result in little or no impact on express bus operation. With upwards of ten express and commuter bus routes available on headways of

TABLE IV-A-15
TRANSIT VOLUMES AND CAPACITIES
PEAK HOUR RIDERSHIP

Line/Segment	Existing*	1990 No-Build Volume	1990 No-Build Percent Increase	1990 Build Volume	1990 Build Percent** Increase	Line Capacity*** Normal	Line Capacity*** Crush
Orange Line/North							
Forest Hills-Oak Grove (N. Station)	10,270	12,310	19.9	12,457	1.2	14,880	18,912
Orange Line/South							
Oak Grove-Forest Hills (Essex Sta.)	7,080	8,508	20.2	8,612	1.2	14,880	18,912
Orange Line/South							
State Street-Washington	7,080+	12,588	77.8	12,985	3.2	14,880	18,912
Green Line/West++							
Cleveland Cir.-N. Station Boston College-Gov't Center Lechmere- Riverside (Arlington Sta.)	7,040	8,774	24.6	8,900	1.4	9,570	12,412
Green Line/East							
Riverside-Lechmere (Science Park)	1,100	1,304	18.5	1,319	1.2	3,630	4,708
Blue Line/North							
Bowdoin-Wonderland (Aquarium)	6,120	7,344	20.0	7,432	1.2	7,040	8,896
Red Line/North							
Ashmont-Alewife Braintree-Davis (Charles)	6,440	7,664	19.0	7,752	1.2	17,952	23,424
Red Line/South							
Alewife-Ashmont Davis-Braintree Park-Quincy (Andrew)	12,120	14,466	19.4	14,635	1.2	26,388	35,136

* All existing ridership figures are for the peak loads at the peak station (in parentheses) at the peak hour.

** Percent increase in 1990 Build vs. 1990 No-Build.

*** Projected line capacities for both the Orange Line and the Red Line are 50 percent greater than existing capacity to account for the lengthening of trains from four cars to six cars in 1987-1988. These line capacities assume that current headways are maintained. Normal capacity includes seating plus standees at 2.5 square feet of space per person. Crush capacity is based upon 1.75 square feet per standee.

\+ Ridership figures were not available for the State Street-Washington segment so Orange Line peak figures were used for a conservative base.

++ The existing ridership and capacity figures do not include the Arborway line which begins at Park Street.

as low as ten minutes, the net increase per vehicle trip is expected to be less than five persons. The MBTA maintain a policy that reduces the potential for standees by releasing buses when seats are filled in order to maintain the high level of ridership. This includes adding buses to the express routes as needed.

Pedestrians

Most pedestrian trips will be transit related (i.e., walking to rapid transit stations or bus stops). Fewer than 700 pedestrian trips a day are expected to be strictly walking trips, with only 63 of those occurring in the peak hour. The majority of transit related pedestrian trips can be expected to use State Street west of the site for access to the State Street and Government Center stations. Red Line passengers may use several different paths to reach Red Line stations or may use State Street to reach the Orange and Green Lines for transfer to the Red Line.

Access from the west will result in increased pedestrian volumes through the Congress Street/State Street intersection. Persons approaching from the State Street Station will be concentrated in the southerly crosswalk with Government Center riders in the northerly and easterly crosswalks.

Based upon the building's layout and elevators most employee entrances to 99 State Street are expected at the Kilby Street entrance opposite Exchange Place. This may result in an approach to the site via Exchange Place and a further change in the pedestrian access paths. The State Street Station is also served by an entrance at the Water Street/Devonshire Street intersection. It is approximately 700 feet from the Kilby Street entrance (versus 600 feet between between the Old State House entrance and Kilby Street) and offers a less congested means of access.

The 1985 Highway Capacity Manual (Special Report 207 by the Transportation Research Board, National Research Council, Washington, D.C.) provides a system for defining pedestrian levels of service based on the sidewalk space provided to pedestrians. As in vehicular levels of service, a ranking system from A to F is provided for walkways and for pedestrian queuing areas. Level of Service "A" within a walkway affords pedestrians the

opportunity to move in desired paths without altering movements in response to other pedestrians. Level "F" is characterized by frequent unavoidable contact with other pedestrians. In Level "C", sufficient space is available to select normal walking speeds and bypass other pedestrians in primarily one-way streams. In Level "D", the selection of individual walking speed becomes restricted as well as the ability to bypass other pedestrian. Table IV-A-16 provides a summary of Pedestrian Level of Service on Walkways.

TABLE IV-A-16
PEDESTRIAN LEVEL OF SERVICE ON WALKWAYS

Level of Service	Space (Sq Ft/PED)	Expected Flows and Speeds: Ave. Speed, S (Ft/Min)	Flow Rate, v (Ped/Min/Ft)	V/C Ratio, vc
A	$\geq$ 130	$\geq$ 260	$\leq$ 2	$\leq$ 0.08
B	$\geq$ 40	$\geq$ 250	$\leq$ 7	$\leq$ 0.28
C	$\geq$ 24	$\geq$ 240	$\leq$ 10	$\leq$ 0.40
D	$\geq$ 15	$\geq$ 225	$\leq$ 15	$\leq$ 0.60
E	$\geq$ 6	$\geq$ 150	$\leq$ 25	$\leq$ 1.00
F	$\geq$ 6	$\geq$ 150	-- Variable --	

Pedestrian count data suggests the worst case time period within the study area occurs between 12:30 and 1:30 PM when almost 1,400 crossings of Kilby Street occurred immediately south of State Street and more than 1,000 pedestrians were observed on the easterly side of Kilby Street near discontinued Doane Street. These crossings are approximately double the peak flows at the same points and are indicative of the high pedestrian demand which exists on a clear day during the summer.

Under existing conditions, pedestrian volumes during the mid-day peak are less than 60 percent of the maximum sidewalk capacity, along the east side of Kilby Street and south side of State Street. General flow is at Level of Service "B" on Kilby Street while on State

Street a Level of Service "C" exists. Applying a "platoon" effect, i.e., accounting for groups of pedestrians, levels of service decrease to "C" and "D", respectively. West of Kilby Street, the State Street sidewalks widen to almost 12 feet. In this are, Level of Service "B" exists even in platoon flows.

The analysis at the Congress Street intersection indicates constriction points on the southwesterly corner and in the Congress Street median north of the intersection. Under ideal operation where pedestrians would wait for the "WALK" signal, insufficient width and storage capacity exist at both points. However, this capacity constraint is not readily visible due to pedestrian crossing habits.

The proposed development includes provisions for widening sidewalks to 12 feet along Kilby Street and providing a constant width walk of 9 to 10 feet along State Street. On Kilby Street this represents a widening of approximately 5 feet. The existing pedestrian demand will continue to be served at Level "B" normally and improve to Level "B" in platoon flows. The widened sidewalk will permit an increase in pedestrian demand of up to 150 percent during the mid-day peak with Level of Service "C" maintained in platoon flow.

The sidewalk capacity along State Street will increase significantly with the elimination of the 6-foot constriction point created by inconsistent building alignment. The constant 10-foot sidewalk will have an effective width of 7 feet accounting for the presence of signs and light poles and will operate at Level of Service "C" under platoon flow conditions. This represents a potential increase in sidewalk flow over existing demand of 47 percent without exceeding Level of Service "C". The demand may increase by 160 percent without exceeding Level of Service "D".

Consequently, the sidewalk revisions proposed as part of the project will provide acceptable levels of service for pedestrians adjacent to the site, even if 1,500 pedestrians were added to both walkways during the mid-day peak.

Parking

The development of 99 State Street includes the provision of 700 spaces. In conformance with the BRA October, 1983 Final Stage Guidelines and Conditions for the Kilby Street Garage Parcel and the City of Boston Air Pollution Control Commission, 450 public spaces will be provided as part of the development program. These will replace the existing 450 usable spaces now within the Kilby Street Garage.

Proposed Layout and Operation

The 700 spaces will be provided in a six-level garage all below ground. Access to the garage will be from Broad Street using the now discontinued Doane Street. Doane Street will be reconstructed and used as a ramp to the facility.

Parking facilities are to be isolated from loading facilities. All site loading and truck activity will use the Kilby Street side of the site accessing loading facilities via Kilby Place.

Unlike the existing operation, which involves motorists queuing at four elevators with a limited at grade storage area between the elevators and Kilby Street, motorists will enter the facility, receive a ticket, and proceed directly to one of the six parking levels. On each of the levels, an attendant will be present to assist in parking approximately 60 percent of the floor's capacity. (A series of tandem spaces have been included in the plan based on the desired number of spaces versus the area per floor and the number of levels which may be accommodated below grade.) Approximately 40 percent of the spaces per level will be self-park.

All ticketing of inbound vehicles will be completed within the first garage level, and not on the Doane Street ramp. The layout of the ticketing machines is currently under review. However, internal operation will be designed to eliminate the potential of back-ups out of the garage to the Broad Street sidewalk, insuring that vehicle movement on Broad Street is not disrupted by a standing queue.

Parking Demand

The 700,000 square foot development will generate the need for 510 long-term employee spaces based on factors previously detailed. These assumed 30 percent of the building's employees arrive via auto with an occupancy rate of 1.8 persons per vehicle. The existing site (exclusive of the Kilby Street Garage) now generates the demand for approximately 100 long-term spaces. The resultant net increase in long-term demand created by 99 State Street is 400 vehicles. The short-term demand applied to building visitors results in a short-term demand of approximately 185 vehicles representing a net increase of approximately 150 vehicles.

Long-term parking available within the garage will be provided for approximately 250 vehicles. The long-term shortfall equals 150, again based on the 30 percent auto arrival rate and 1.8 person per vehicle occupancy.

This shortfall represents a conservative analysis of conditions within the northerly portion of the Financial District. The 30 percent factor is one which is average in an area which is not readily served by transit and where adequate, reasonably priced parking is provided. A review of the parcels adjacent to the development site suggests a mode split of 20 percent auto use would be more in order.

Applying the 1.8 factor with 20 percent rate to employee parking indicates the need for 335 spaces. These revised rates applied to the existing use, results in a current demand for 68 spaces and a net increase in parking demand of 267 spaces. This is consistent with what is being supplied.

With the general trend of 20 percent auto usage within the immediate area, the provision of 250 spaces will be consistent with long-term parking demand. Short-term demand will exceed available capacity on a daily basis by approximately 150 vehicles. A variable which may result in further auto travel reduction is the pricing structure of the new facility which has yet to be defined. An increase in the daily rate from the current level of $9.00 to $12.00 or $15.00 will more than likely alter long-term parking patterns, freeing those space for short-term users.

Note that if such a shift should occur away from autos to transit, the increased demand would still be will below system capacity. The one percent increase previously noted would continue to be in order.

Construction Impacts

Parking

During the construction of 99 State Street, the area will experience a loss of the current 450 space capacity of the Kilby Street garage. As previously noted, other facilities in the area are approaching capacity based on the loss of other lots and garages to construction. The fact that limited space is available will force vehicles to parking lots or structures a greater distance from the site, to mass transit or to a combination of both. Some relocation to the North Station area with access to the Green Line is anticipated.

Recognizing that demand for spaces in other areas will begin to increase toward the end of the construction period, it is anticipated that the 700-space garage may be returned to service during the late summer or early fall of 1988 albeit on a limited space basis.

Construction Employee Trip Generation and Parking

The number of workers required over the two and one-half to three year construction period will vary but it is estimated that the peak at any given time will be about 300.

Trip generation by construction workers is a direct function of employment levels. Assuming an auto occupancy of two or three persons (based on the shortage of parking, costs and increased inclination of construction workers to carpool), the 300 employees during the peak construction period would generate approximately 120 to 150 one-way trips if all employees commute by automobile. In fact, a portion of the construction workers will utilize public transportation due to the downtown location of the site. In addition, construction workers generally travel before the peak hours, so they do not add to commuter peak hour traffic. Therefore, no significant impact to the area roadway system is anticipated.

It is assumed that the 120 to 150 generated trips will either park in available spaces in the area or around the construction site, or that workers will shift to rapid transit. This assumption is reasonable in light of the recently completed Copley Place development, a large project for which no construction parking arrangement were made. The daily cost of off-street parking in the area will also encourage lower auto use.

MITIGATION MEASURES

As a result of developments approved or under construction in the Financial District, along the waterfront or in the Government Center area, significant traffic growth can be expected within the study area throughout the remainder of the decade. Most intersections in the area will be able to absorb the expected growth and maintain acceptable levels of service. However, the intersections of Congress Street/North Street, Congress Street/Purchase Street and High Street/Surface Artery/Atlantic Avenue are projected to receive volumes in excess of their current capacities. Although this impact would occur even without the proposed 99 State Street development, it is important to recognize the growth trend and to identify any mitigation measures which might provide improved levels of service.

This subsection presents a mitigation program in two categories: "Traffic Operations" measures involve localized intersection and sidewalk improvements which may be implemented to reduce or alleviate the impact of background growth and/or development related vehicle-trips "Demand Reduction/Management" describes opportunities to reduce the actual levels of traffic associated with the development.

Traffic Operations

Traffic operations improvements involve signal timing and operation revisions, parking restrictions, implementation of one-way operation to relieve traffic flow or provision of two-way movement to provide an alternative means of access, and pedestrian level improvements among others. The City is currently in the process of modifying traffic signal operations at approximately 250

intersections encompassing most of the Downtown including the study area. Many of the items noted below will be addressed in the modifications prior to the completion of the 99 State Street project.

The following provides a description of mitigation measures relating to traffic operations.

Congress Street/North Street

Under 1990 Build conditions, the Congress Street/ North Street intersection is expected to operate at LOS "D/E" in the morning peak hour and at LOS "E" in the evening peak hour. The development of 99 State Street will have a minor impact resulting in a 0.03 increase in the maximum volume/capacity ratio.

Observation and analysis of the operation of the Congress Street/North Street intersection during the evening peak hour suggested that current signal timing may not be appropriately set for current volumes. It appeared that too much time was given to the North Street approach and too little time given to the advanced green on the Congress Street north approach.

Analysis further indicates that green time is properly allocated for morning peak hour volumes. This is one of the mitigating actions which will be completed with the computer controlled signal system.

Improved flow, most notably during the evening peak hour, under No-Build or Build conditions, could be realized through the provision of an exclusive right-turn lane from Congress Street northbound to North Street. This would require the elimination of parking and the tour bus stands along the easterly side of Congress Street during the evening peak hours.

Congress Street/Purchase Street

Although parking is restricted on both approach roadways in peak periods, violations of the restrictions reduce the availability of the lanes for traffic. The analyses of the intersection did not include the use of these lanes. Therefore, to the extent that parking restrictions are observed and the lanes made available for

traffic, reduced volume-to-capacity ratios and perhaps improved levels of service would be possible. Further improvements will again be realized with computer control. (Currently, the Congress Street/Purchase Street intersection is not part of the Congress Street system.) With minor revisions to the signal program and the point at which the exclusive pedestrian phase is called substantial, corridor level improvements may be realized.

High Street/Surface Artery/Atlantic Avenue

This intersection is projected to operate at LOS "E" in both the morning and evening peak hours with demand in excess of capacity. No geometric or operational improvements appear to be possible to provide additional capacity. It is possible that a change in timing might be desirable as volumes increase and the relative demand on each approach shifts. However, the current operation of the signal appears to handle existing volumes efficiently. The intersection should be monitored to determine if shifts in volumes warrant a revised signal operation.

Congress Street/State Street

Although projected to operate at LOS "D" in the morning and LOS "C" in the evening, this intersection should be monitored to assure proper operation. If needed, capacity could be increased by imposing peak period parking restrictions along the southerly side of the State Street approach. This would allow for a more continuous operation of three approach lanes which would provide greater capacity. The approach should also be marked as to lane usage. As with other signalized intersections, operation should be monitored to assure that signal timing is consistent with approach demands.

One further action at this intersection which should be considered is the use of a concurrent pedestrian crossing phase, i.e., one which provides for pedestrian crossings when vehicles are moving. Concurrent protected crossings are now permitted on State Street both east and west of the intersection with a partial protected crossing of Congress Street north of State Street (southbound lanes only). Upon pedestrian actuation, all vehicles approaching the intersection are stopped to permit a crossing of Congress Street south of

the intersection and the northbound lanes north of the intersection. The time for this crossing is taken from State Street "green" time. Under the concurrent crossing proposal, pedestrians would be given a walk signal in both Congress Street crosswalks when vehicles on State Street were given a green indication. South of the intersection, conflicts between pedestrians and vehicles would be limited as only 60 left turns per hour exist from State Street to Congress Street. North of the intersection, conflicts would be more prevalent because of the 200 vehicles per hour right-turn volume. However, current pedestrian habits within the intersection have already created this conflict as pedestrians are not waiting for the exclusive phase in either crosswalk. The elimination of the exclusive phase will provide adequate green time for State Street and provide pedestrians with additional time to cross with less delay.

Surface Artery/State Street

The Surface Artery/State Street intersection will be upgraded as part of the current signalization program. The provision of a northbound leading left green phase has already been detailed. In addition, the use of YIELD sign control should be considered for the right-turn movement from Surface Artery southbound to State Street. The right-turn area is separated from the through lanes by a small delta island making yield control feasible. To insure access to the right lane, it should be established as a right-turn only lane within 100 feet of State Street with tour bus parking prohibited during the morning peak.

Water Street

As part of the elimination of access to the parking structure via Kilby Street, Water Street should be established as a one-way eastbound roadway from Liberty Square to Broad Street. This will provide a connection between Beacon Street and Broad Street via School Street and a segment of Washington Street. It will replace the Batterymarch Street to Milk Street extension of Water Street to reach Broad Street and reduce conflicts within the Liberty Square area.

Kilby Street

Currently, Kilby Street is one-way northbound from Water Street to State Street and two-way south of Water Street. Although access to the garage will be removed from Kilby Street, Kilby Place (the current garage entrance) will be used for truck deliveries. It is recommended that the 100-foot section of Kilby Street between Water Street and Exchange Place be made two-way to allow 99 State Street truck traffic an alternative way to exit the site. Without the change, all truck traffic would exit through the Congress Street/State Street intersection. However, with the change, truck traffic could use Exchange Place or could go south on Kilby Street, thereby avoiding the State Street/Congress Street intersection.

Pedestrian Treatment

Sidewalks along the State Street and Kilby Street frontages are being widened as part of the Project. On Kilby Street, the widening from 6 feet to 12 feet in the area of Doane street will provide a significant increase in sidewalk capacity. On State Street the widening is limited at the ends of the parcel but will reach four feet near the center of the parcel. Overall, a ten-foot walk will be provided with the existing curb lines maintained.

Demand Reduction/Management

Rather than respond to problems created by uninhibited traffic growth, an effective alternative often involves reducing the amount of traffic generated and/or managing it more efficiently. The promotion of the use of mass transportation and ridesharing together with parking management techniques are readily identifiable elements of this mitigating action.

Ride Sharing and Mass Transportation

- Preferential treatment for carpools/vanpools.

- Promotion of Caravan (an organization which leases commuter vans and provides some administrative organizational help) or other van leasing program, if economically feasible.

- Promotion of the MBTA pass and private bus line commuter ticket programs.

- Provision of a carpool/vanpool matching service, if economically feasible.

- For employees able to commute via bicycle, provision of a secure bicycle storage area at no charge.

Parking Management Techniques

Perhaps the most effective mitigation measure involves the analysis assumption that all those desiring to access the proposed Project via automobile would find a parking space at their destination, i.e., an "unconstrained" approach. In reality, due to physical space limitations and policy decisions on the amount and type of parking that is appropriate for the project in particular and the area in general, such will not be the case. The demand/supply estimates indicate a small shortfall in long-term (all-day commuter) spaces and a larger deficit of short-term spaces. It is reasonable to conclude that a sizeable portion of this excess auto demand (if not all) will simply shift mode to public transportation, especially since excess capacity is anticipated on rapid transit lines feeding the area if appropriate measures are taken to encourage the shift.

More specific parking-related actions which will help to control the level of auto demand and/or to manage its impacts, including:

- The location of the first garage level below grade will result in ticketing control points that eliminate the need for on-street queuing on entry.

- The use of Broad Street for parking access.

- The Project proponent should discourage excessive demand for auto access by structuring its parking price policy in an appropriate way.

INTRODUCTION

The objective of the air quality analysis is to determine if the proposed 99 State Street Project will interfere with the attainment or maintenance of Massachusetts and National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO). The NAAQS were established by the Federal Clean Air Act, and are designed to protect public health and welfare. To demonstrate compliance, it was necessary to identify human activity centers (sensitive receptors) exposed to maximum air pollutant levels from motor vehicle emissions in the project area. Using air quality modeling techniques, CO levels were estimated at these sensitive receptors for the Build and No-Build alternatives for the present and future years. Comparison of projected pollutant levels to the NAAQS permited evaluation of whether motor vehicle emissions related to the proposed development will pose a threat to public health or welfare.

Analysis indicates that project development will not interfere with the attainment of NAAQS for CO, and that CO levels in 1990 under either no-build or build conditions are expected to be lower than current conditions. In addition, the impact of parking garage ventilation air on maximum CO concentrations at nearby pedestrian areas and building fresh air intakes has been showm to be minimal.

DESCRIPTION OF THE ENVIRONMENT

Pollutant Sources and Effects

The key source of project-related air pollution is from motor vehicles visiting the project site. Of the various air pollutants emitted, CO is used in this analysis as an indicator of roadway air pollution levels, since it is the most abundant and persistent pollutant emitted by motor vehicles. Also, since CO is a non-reactive substance, its concentration in the air can be easily predicted.

The adverse health effects of CO are a result of its combination with blood hemoglobin to form carboxyhemoglobin (COHb). This compound interferes with the life-sustaining transfer of oxygen from the lungs to the body tissues, and the return of carbon dioxide from the tissues to the lungs. The presence of relatively small amounts of CO results in significant interference

with essential cardio-vascular-respiratory functions. Brief exposure to high levels of CO can impair vision, physical coordination, and the perception of time.

NAAQS for CO have been set by the U.S. Environmental Protection Agency (EPA). Standards for the Commonwealth of Massachusetts are identical to Federal standards. The standardss, intended to protect the public health, set a maximum concentration of 35 parts per million (ppm) for a 1-hour period and 9 ppm for 8 hours, each not to be exceeded more than once per year. The target date for attainment of national CO standards in Massachusetts is December 31, 1987.

Background Air Quality

In urban areas such as Boston there is always present in the air a fairly constant and diffuse level of CO due to the numerous sources spread throughout the city and beyond. Such sources include all stationary fuel combustion facilities, as well as motor vehicle emissions on urban roadways. This diffuse level of air pollution is called the background level.

Background air quality can be determined by monitoring and testing air samples; however, no state monitoring station exists at the site. Background levels of CO were taken from the Final EIR for Rowes Wharf, a nearby development. These levels are assumed to be 5.0 ppm (1-hour average) and 3.0 ppm (8-hour average) for 1985. It is necessary to estimate a value for the background CO level in this study since it is added to the impacts of local sources (i.e., roadway intersections in the traffic study area, and ventilation air emitted by project parking garage exhaust ducts) in determining whether air quality at a particular location complies with the NAAQS.

Methodology for Estimating Air Quality

The technical approach used to predict ambient air quality was reviewed by the Massachusetts DEQE 1. The analysis calculated maximum 1-hour and 8-hour CO concentrations at three sensitive receptors near the intersection of State Street and Broad Street in the project area for the three cases on the following page:

Case No.	Year	Development Alternative
1	1985	Existing Conditions
2	1990	No-Build
3	1990	Build

The intersection of State Street and Broad Street was selected for analysis because of the predicted change in roadway Level of Service due to the project (see Section IV A).

Two mathematical models were used to predict air quality concentrations and their effects. The first, MOBILE-3 [2], was used to calculate the emissions of CO at the intersection based on traffic flow. The second model, CALINE-3 [3], was used to preduct concentrations of CO at sensitive receptors near the intersection. A description of the technical approach and receptor locations is given in Appendix F.

A separate analysis of the impact of the proposed 99 State Street underground garage ventilation system was conducted for the 1990 Build case. Maximum 1-hour and 8-hour concentrations were predicted using a dilution calculation and Halitsky's model for near-field receptors [1].

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1 Personal communication to Mr. Jerome Grafe, Massachusetts Division of Air Quality Control, DEQE, Boston, MA, November 25, 1985.

2 EPA, User's Guide to MOBILE-3 (Mobile Source Emissions Model), EPA-460/3-84-002, Ann Arbor, MI, June 1984, including software corrections from EPA dated May, 1985.

3 California Department of Transportation, CALINE-3, A Versatile Dispersion Model for Predicting Air Pollutant Levels Near Highways and Arterial Streets, FHWA/CA/TL-79/23, Sacramento, CA, November, 1979.

PROBABLE PROJECT IMPACTS

The air quality analysis predicted maximum 1-hour and 8-hour CO concentrations at three sensitive receptors, as shown in Exhibit IV B-1.

Intersection Analysis

The cumulative results of the air quality analysis, including impacts from intersection traffic and background carbon monoxide, are presented in Table IV B-1. These results do not characterize typical air pollution levels in the project area. Rather, they represent the highest concentrations that could exist during the joint occurrence of worst case meteorology and peak traffic.

Existing Conditions

The modeling results for existing conditions show maximum 1-hour CO concentrations in the range from 9.0 to 10.9 ppm. Maximum 8-hour CO levels for the intersection studied range from 4.7 to 5.5 ppm. All existing concentrations are in compliance with the NAAQS.

1990 No-Build

The modeling results for the 1990 no-build scenario show a significant improvement in air quality due to the predicted decrease in the average motor vehicle emission rate. The average emission rate decreases with time as a larger portion of the vehicle population becomes equipped with full emission control equipment, and a larger portion of the vehicle population is held to stricter emission limits through the Commonwealth's Inspection and Maintenance Program.

For the 1990 no-build case, all 1-hour and 8-hour CO concentrations are in compliance with the NAAQS. Maximum 1-hour values range from 6.4 to 7.6 ppm, while 8-hour values run from 3.4 to 3.8 ppm.

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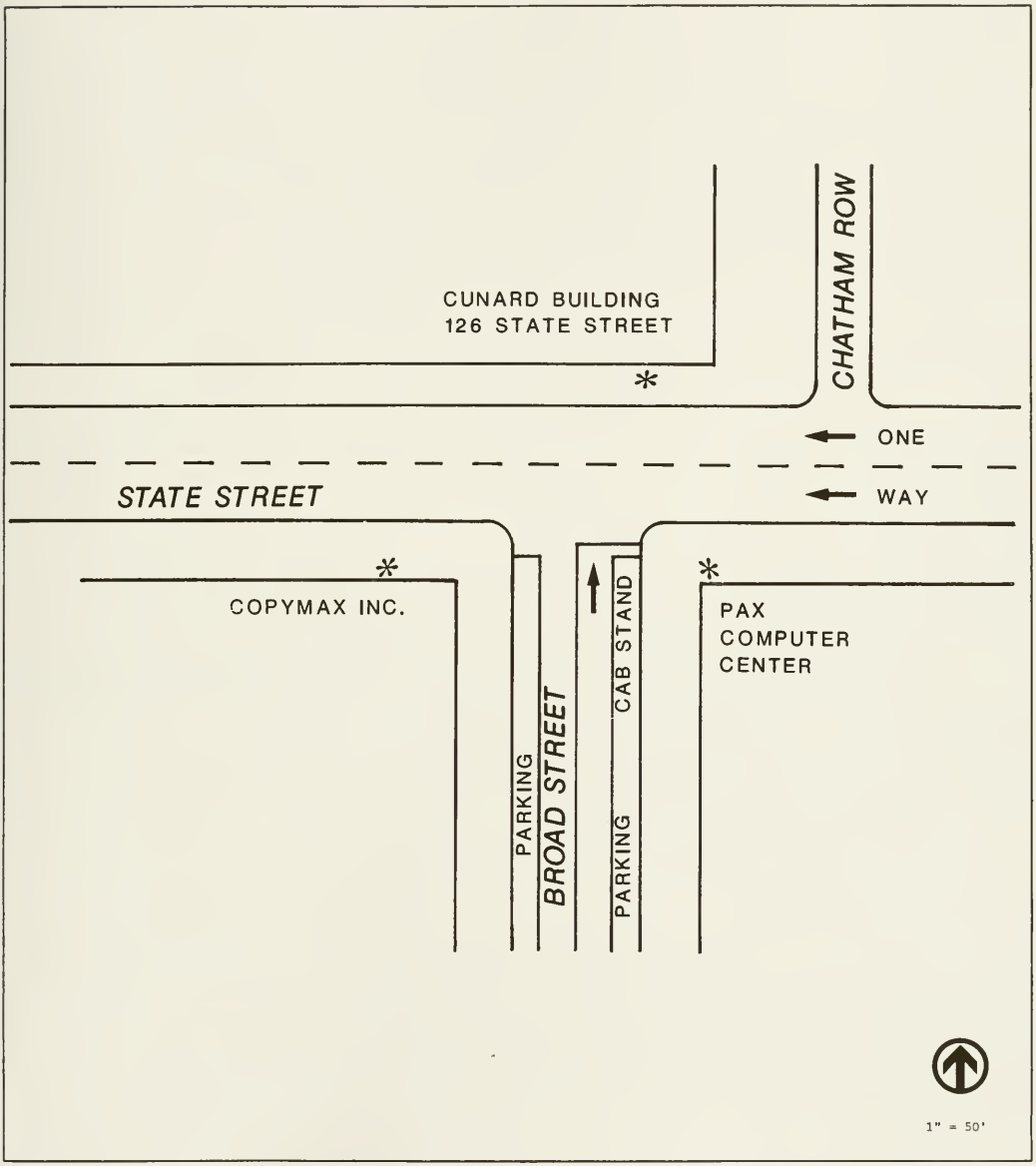
1 Halitsky, J., "Gas Diffusion Near Buildings," Meteorology and Atomic Energy 1968, U.S. Department of Energy (NTIS TID-24190), 1968, pp. 246-252.

AIR QUALITY RECEPTORS - STATE STREET AND BROAD STREET



1990 Build

The predicted CO concentrations under the 1990 development as planned are all in compliance with the NAAQS. Maximum 1-hour CO levels range from 6.6 to 7.9 ppm, while 8-hour values run from 3.5 to 3.9 ppm. The project adds only 0.1 ppm to maximum 8-hour CO concentrations at the three sensitive receptors. This increase is only 1% of the NAAQS (9 ppm) and is therefore insignificant.

Summary of Intersection Analysis

Maximum 1-hour and 8-hour CO concentrations are currently in compliance with the NAAQS at the intersection of State Street and Broad Street in Boston. Predicted air quality in 1990 indicates all concentrations at this intersection will be in compliance with the NAAQS for both the Build and No-Build cases. Thus, it can be concluded that the 99 State Street project will not interfere with the attainment or maintenance of the NAAQS for CO.

TABLE IV B-1

Predicted Maximum CO Concentrations Plus Background at the Intersection of State Street and Broad Street

Scenario and Receptor Location	CO Concentration (ppm) 1-Hour	8-Hour
1985 Existing Conditions		
Cunard Building	10.9	5.3
Pax Computer Center	10.9	5.5
Copymax, Inc.	9.0	4.7
1990 No-Build		
Cunard Building	7.6	3.8
Pax Computer Center	7.4	3.8
Copymax, Inc.	6.4	3.4
1990 Build		
Cunard Building	7.9	3.9
Pax Computer Center	7.6	3.9
Copymax, Inc.	6.6	3.5

Parking Garage Analysis

An analysis of the impacts of the ventilation system for the underground garage was conducted for the 1990 Build case. Maximum 1-hour and 8-hour CO concentrations were predicted at two sensitive receptors on the site. See Table IV B-2. Background concentrations are accounted for in these estimates. The garage will have one exhaust duct in the service area along Kilby Place. Impacts were predicted for the nearest pedestrian area on Kilby Street, and for the fresh air intake duct for the development.

TABLE IV B-2

Predicted Maximum CO Concentrations Plus Background at Two Receptors Affected by the 99 State Street Parking Garage Ventilation System, for the 1990 Build Case

	CO Concentration (ppm)	
Receptor Location	1-Hour	8-Hour
Pedestrian Area on Kilby Street	8.6	3.5
Fresh Air Intake Duct	7.3	3.2

The modeling results show that worst case 1-hour CO centrations from the garage ventilation air will range from 7.3 to 8.6 ppm. These levels are less than 25 percent of the 1-hour NAAQS of 35 ppm. Worst-case 8-hour CO concentrations at the same receptors run from 3.2 to 3.5 ppm. These levels are less than 40 percent of the 8-hour NAAQS of 9 ppm. It can be concluded that emissions from the 99 State Street parking garage will not interfere with the attainment or maintenance of the NAAQS for CO in the project area.

MITIGATION MEASURES

Intersection Analysis

The 99 State Street project will cause an insignificant increase in maximum 1-hour and 8-hour CO concentrations in 1990 at the intersection of State and Broad Streets. All worst case concentrations will be in compliance with the NAAQS, and thus, no mitigation measures are proposed.

Parking Garage Analysis

The impact of parking garage ventilation air on maximum CO concentrations at nearby pedestrian areas and building fresh air intakes has been shown to be minimal. All worst case concentrations will be in compliance with the NAAQS, and, thus, no mitigation measures are proposed.

SEWER SYSTEM

Introduction

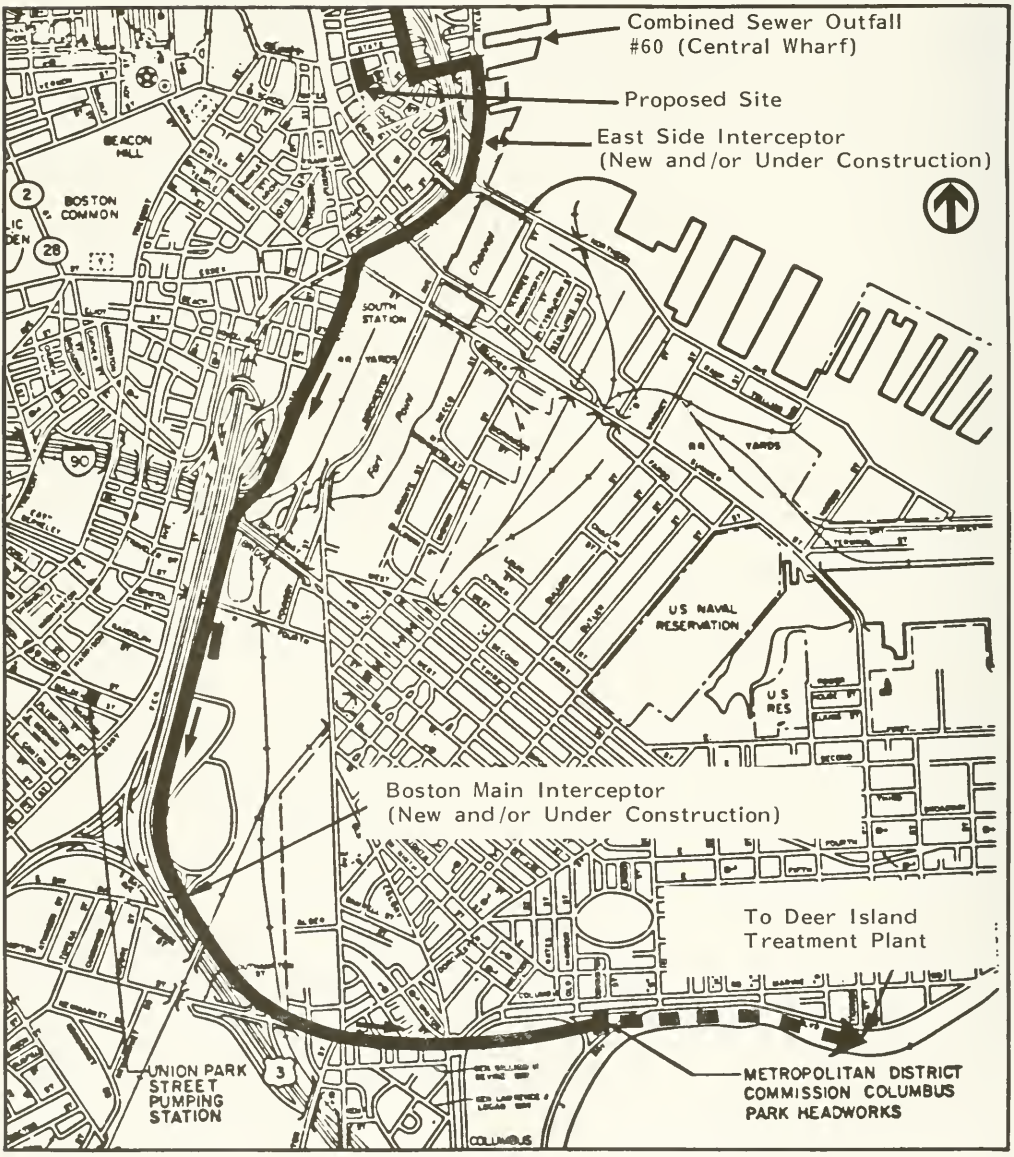
Principal sewer-related activities planned to be part of the 99 State Street Project include the following:

- Removal of an existing 67" combined sewer which is currently located below the Kilby Street Garage.
- Construction of a new combined sewer from the intersection of Kilby Street and Water Street, easterly along Water Street, to the intersection of Broad and Central Street.
- Construction of a new storm sewer from the intersection of Kilby and Doane Streets, along Water Street, Broad Street, and Central Street to McKinley Square.
- Creation of a new storm drainage system for the project and its immediate surroundings designed to discharge into the new storm sewer system.
- New service connections for the proposed 99 State Street Project.
- Provision of new service connections for buildings affected by reconstruction of Doane Street.

In terms of sewerage, the most important overall effect of the project is the establishment of a system of sewers from Liberty Square to McKinley Square in which sanitary and storm flows can be carried separately, rather than in a combined system as currently exists.

Principal water-supply related activities planned to be part of the 99 State Street Project include the following:

- Extension of high-pressure fire service lines in Broad and Kilby Street in order to re-establish loop service terminated as a result of abandonment of a high-pressure line in Doane Street.
- New service connections for the proposed 99 State Street Project.


Combined Sewer Outfall
#60 (Central Wharf)
Proposed Site
East Side Interceptor
(New and/or Under Construction)
BEACON HILL
BOSTON COMMON
SOUTH STATION
US NAVAL RESERVATION
US RES
Boston Main Interceptor
(New and/or Under Construction)
To Deer Island
Treatment Plant
UNION PARK STREET PUMPING STATION
METROPOLITAN DISTRICT COMMISSION COLUMBUS PARK HEADWORKS
COLUMBUS

1" = 100'

- Reconstruction of domestic water supply lines in Doane Street as part of roadway modifications required by the project.

The following section describes the existing system of water and sewer facilities serving the project site, assesses the impact of the project on such facilities, and discusses mitigation measures planned to ensure that the project results in a beneficial effect on the area water and sewer system.

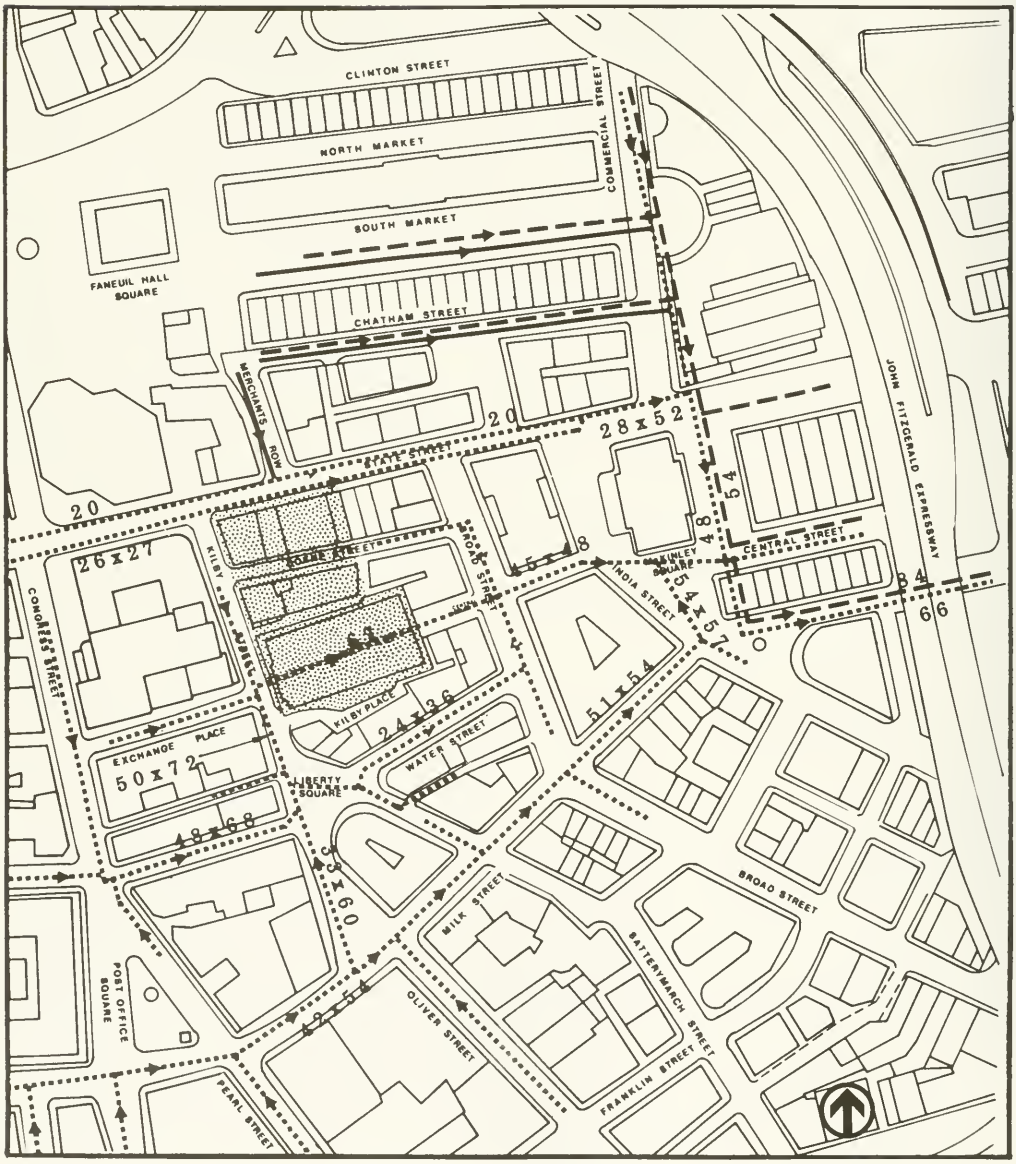
Existing Conditions

Overview

The existing combined sewer system around the proposed development site is shown on Exhibits IV C-1 and IV C-2. The main trunk sewer services the area of the proposed development as well as an upstream contributing area of approximately 22 acres. This contributory area includes the blocks bounded by State and Water Streets between Kilby and Washington Streets, as well as the area bounded by School and Bromfield Streets between Washington and Tremont Streets. A section of Beacon Street between Tremont Street and the Statehouse is also part of this contributing area. Flows from these contributory blocks approach the site area via Water Street.

The sewer serving the site runs easterly in a 48-inch x 68-inch structure beneath Water Street to Liberty Square, northerly in a 50-inch by 72-inch structure beneath Kilby Street to its intersection with Exchange Place and then easterly in a 67-inch diameter concrete structure under the Kilby Street Garage. The sewer then runs in a 45-inch by 48-inch structure beneath Central Street to McKinley Square, where it joins the East Side Interceptor. As discussed in the following Project Impacts section, the portion of this system which runs below the Kilby Street Garage will be removed and reconstructed in a new alignment as a separated system, in order to allow for demolition of the garage structure.

All sanitary and combined sewage is carried from the site area to treatment facilities via the East Side Interceptor. In this area, the East Side Interceptor system consists of a pipe 66 inches in diameter which



IV C-4 Water and Sewer Service

carries combined sewer flows southerly beneath Atlantic Avenue to the Boston Main Interceptor and on to the Deer Island Treatment Plant. Flows in this combined system are presently restricted to approximately 9 mgd capacity by a section of the old East Side Interceptor between High Street and South Station on Atlantic Avenue. Replacement of this section of the Interceptor is now under final design and is scheduled to be in place in 1989 at which time the capacity will be increased to approximately 36 mgd.

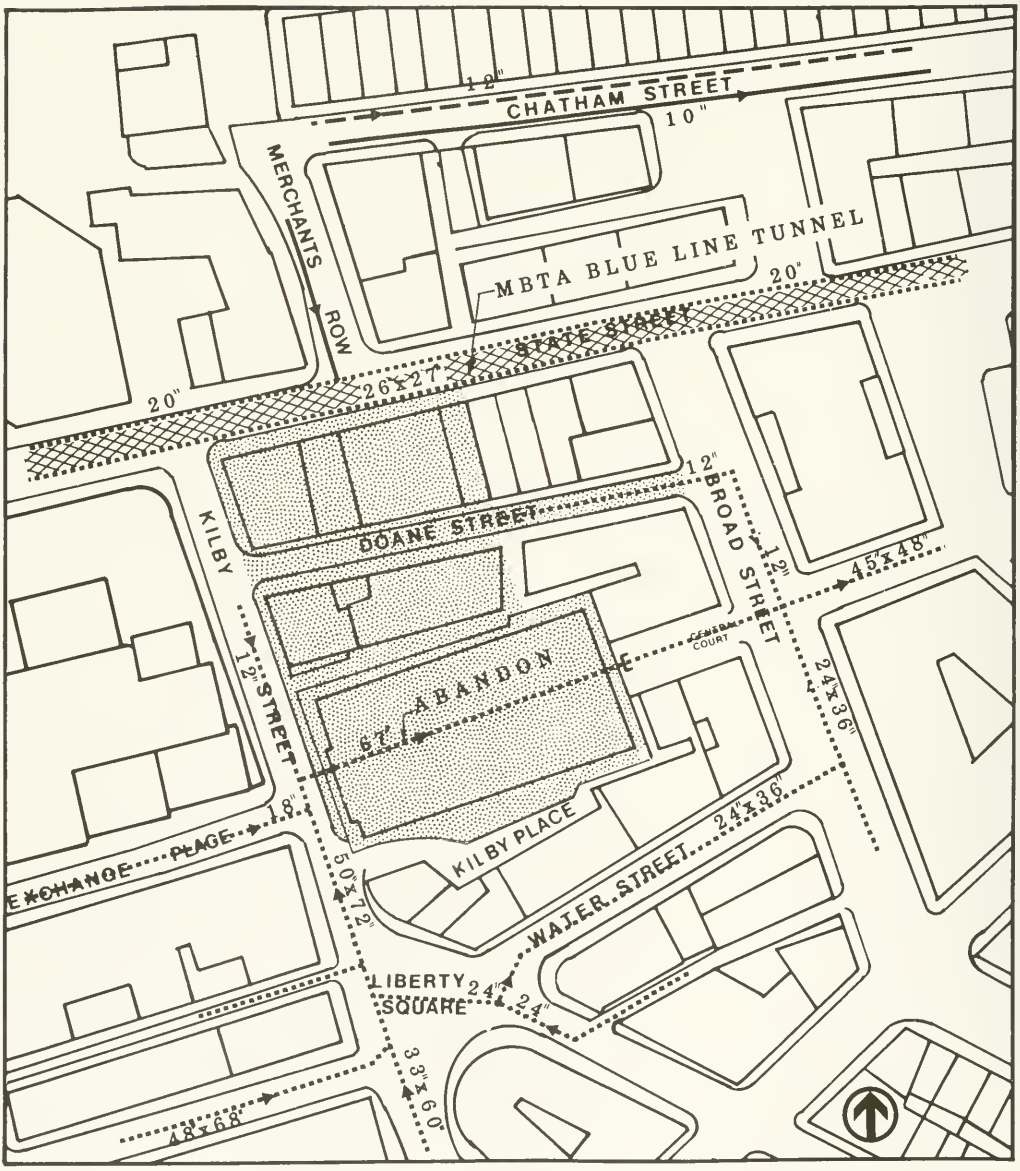
The closest separated storm drain system to the site is a 72" diameter storm drain which runs parallel to the East Side Interceptor into McKinley Square and then continues in an 84-inch diameter pipe along Milk Street under the Fitzgerald Expressway to Central Wharf, where it joins the 72-inch by 72-inch brick combined sewer structure running beneath Central Street (see Exhibit IV C-2). The sewer then runs to its point of discharge to the Boston Harbor at Combined Sewer Outfall Number 60, located at the end of Central Wharf (beneath New England Aquarium).

System Components

Components of the sewer system previously discussed are described in further detail below, categorized according to street location. This detailed description is presented so as to provide a better understanding of proposed changes and improvements described in the subsequent Project Impacts section. The system described is illustrated in Exhibits IV C-2 and IV C-3.

State Street. There are two combined sewer lines running beneath State Street that were built as integral parts of the MBTA's Blue Line tunnel. The sewer line located on the north side of the tunnel is a 20-inch diameter structure which collects the storm drainage and sewage discharge from areas located on the north side of State Street. The line located on the south (project) side of the tunnel is a 26-inch by 27-inch structure which collects the storm drainage and sewage discharge from areas located within the proposed development site, as well as from adjacent parcels. These lines carry flow to the intersection of State Street and Commercial Street where they enter the East Side Interceptor.

EXISTING PROJECT AREA SEWER SYSTEMS



As these lines were constructed integrally with the MBTA structure and are draining large upstream areas, Boston Water and Sewer Commission (BWSC) personnel have recommended that they not be considered as points of discharge for project-related storm drainage or sanitary sewage. The Proponent has accepted this recommendation, and plans to utilize Broad Street sewerage via either Central Street or Doane Street for project related storm and sanitary flows.

Kilby Street. A 12-inch diameter combined sewer line runs from the intersection of Kilby Street and Doane Street southerly beneath Kilby Street to the main trunk sewer described above at the intersection with Exchange Place. According to BWSC, this line is not functioning in the vicinity of Bangs Alley and is not available to carry site-generated flows. This system will be reconstructed to carry storm drainage from the revised street layout required for the development.

Exchange Place. An 18-inch and 24-inch combined sewer line runs beneath Exchange Place to its intersection with Kilby Street where it discharges into the main trunk line. This line carries storm drainage as well as sewage from buildings along Exchange Place.

Doane Street. A 12-inch diameter combined sewer pipe collects storm drainage from the Bangs Alley area as well as storm drainage and sanitary sewage flow from along Doane Street, and carries this flow to the existing 12-inch combined sewer line located in Broad Street (described above).

Broad Street. A 12-inch diameter combined sewer pipe runs beneath Broad Street from its intersection with Doane Street to the trunk line at the Broad Street intersection with Central Street. This line collects storm drainage and sanitary sewage flow along Broad Street as well as carrying flows generated in the Doane Street system.

An 18-inch by 27-inch and 24-inch by 36-inch combined sewer structure runs beneath Broad Street from its intersection with Crab Alley (between Milk and Water Streets) to the trunk line at Broad Street's intersection with Central Street. This line collects combined flows along Broad Street, including that from a combined system in Water Street.

Water Street/Liberty Square. 24-inch diameter pipe and a 24-inch by 36-inch combined sewer structure collects flows from Crab Alley, Batterymarch Street, Liberty Square and Water Street and carries them to the 24-inch by 36-inch combined sewer structure in Broad Street (described above).

East Side Interceptor/Boston Main Drain/Deer Island Treatment Facility. The East Side Interceptor (ESI) conveys combined sewer flows from the Downtown Boston area to the Boston Main Interceptor at Massachusetts Avenue and Albany Street (see Exhibit IV C-1). The ESI begins at Hanover Street and extends southerly along Commercial Street, through McKinley Square, and then along Atlantic Avenue to Dewey Square, then southerly beneath the South Station railroad yards to Albany Street and then along Albany Street to the Boston Main Drain at the intersection with Massachusetts Avenue. The Boston Main Drain collects combined sewer flows from various interceptors, including the ESI, and carries them to the MDC system near Columbus Park which conveys them on to the Deer Island Sewage Treatment Facility.

The East Side Interceptor has been reconstructed from the Haymarket area to the Harbor Towers area by the BRA as part of several Downtown redevelopment projects. The BWSC has been in the process of reconstructing the remaining portion of the ESI, and projects that the new system will be in place by 1989. This newly reconstructed system will have a much greater design capacity than the existing system. The restricting section now has a capacity of approximately 9 mgd and the new system in the same area will have greater than approximately 36 mgd.

The BWSC is projecting that once this system is in place, the Commission will be able to remove present requirements restricting flow into the system during high tide periods. The Commission also projects that dry weather overflows from the combined system to the harbor will be eliminated, and that overflows during storm periods will be significantly decreased. This program to increase the capacity of the ESI is being complemented by BWSC efforts to separate storm and sanitary sewerage in the downtown area, thus reducing the volume of flow to be carried to treatment facilities.

Probable Project Impacts

Introduction

The proposed project is discussed here according to three categories of subject matter:

- Required changes to the existing combined sewer system - This issue centers on the need to relocate the 67" combined sewer which currently exists below the Kilby Street Garage, so that garage demolition and subsurface construction can occur without service interuption. As discussed in the following section, the construction of a separated system within a Water Street alignment is proposed as a replacement for the 67" combined sewer.

- Service Impacts - This issue involves means of ensuring continued sewer service to buildings currently served by an existing 12-inch combined sewer in Doane Street, a roadway which will be reconstructed as part of the proposed project.

- Site Volume Impacts - This issue involves the increase in sewage volume discharged to the sewer system from the site as a result of the proposed development. As discussed in the following section, although sewage flow will increase, significant storm flows will also be removed from the combined system as a result of the project. No increase in site runoff will occur.

Required Changes to the Existing Combined Sewer System

As shown on Exhibit IV C-3, the proposed development is to be constructed in the area where the 67-inch diameter combined sewer trunk line presently runs beneath the Kilby Street Garage. This line must be relocated to allow for the construction of the proposed parking facility and foundation system for the proposed development. The proposed reconfiguration of the sewer system is shown on Exhibit IV C-4.

This new system will be comprised of two separate lines. One line will receive sanitary sewage generated on-site, as well as combined sanitary/storm flow from combined sewers upstream. This line will run from the existing trunk line in Liberty Square, beneath Water

Street and Broad Street, to the existing combined system at Central Street. The second line will be constructed along the same alignment to receive storm water flows from the site as well as stormwater flows from upstream drainage areas in the future. This additional line will run from Liberty Square, beneath Water Street, Broad Street and Central Street, to McKinley Square, where it will connect with the existing separate storm drain system which parallels the ESI (and which drains portions of the North End), leading to an outfall at Boston Harbor.

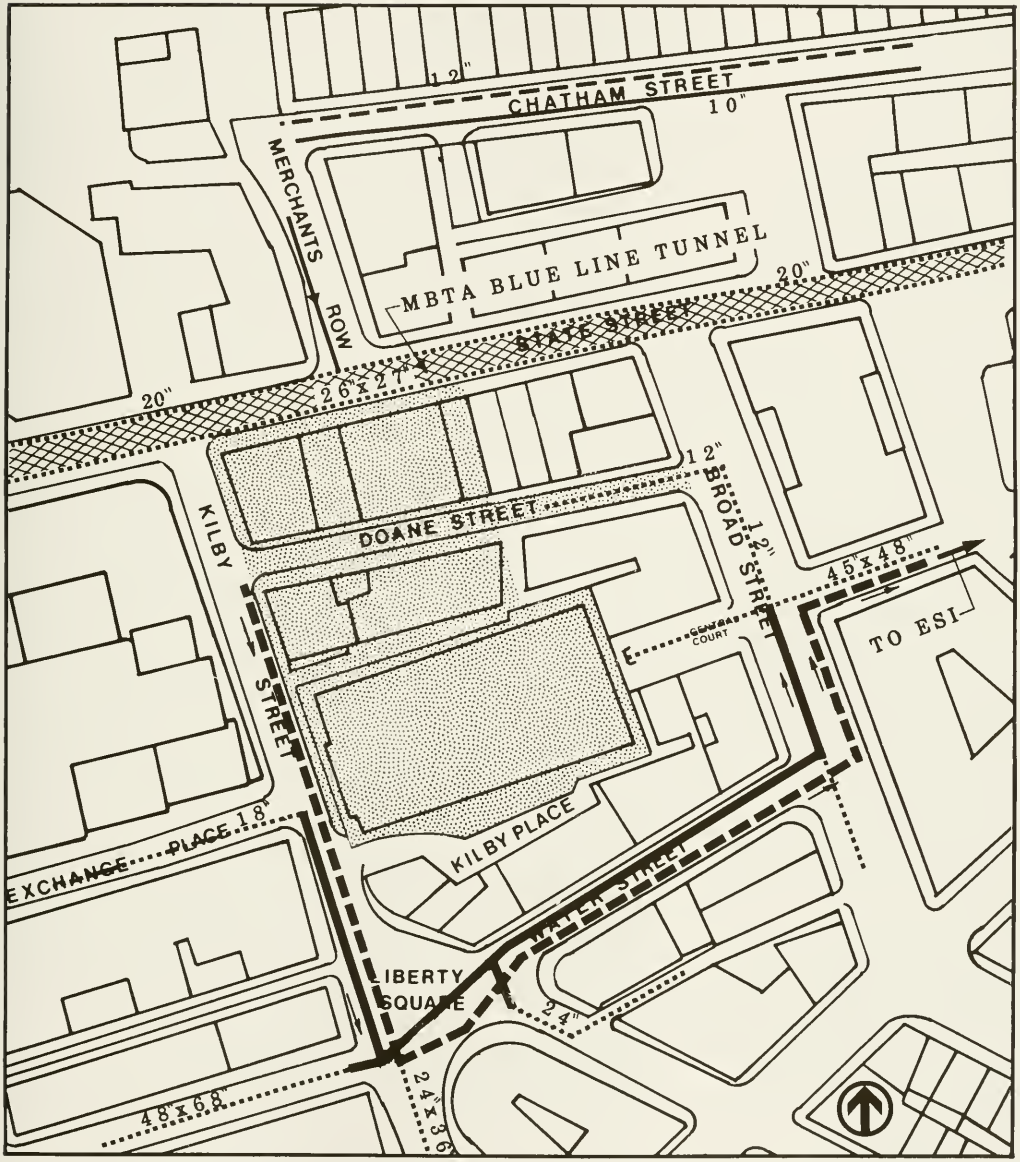
The details for this system, with respect to size and location of the facilities, are presently under study with the BWSC. The storm drain system will be sized to allow for its continuation by the BWSC to ultimately separate storm drainage from the upstream contributing area. The definition of the contributing area which this system must be designed to serve in the future is part of an ongoing study by BWSC. In addition, the separation of existing combined sanitary/storm sewerage leading from area buildings with service connections in pertinent sections of Water, Broad and Central Streets will be made possible as a result of construction of this new system.

Service Impacts

Six area buildings to remain after project construction are serviced by the 12-inch diameter combined sewer line located beneath Doane Street. Several alternative treatments are presently under study by the consulting engineers and BWSC that would allow for the roadway reconstruction required by the proposed development while maintaining these services. The alternative chosen will depend on the finalization of the proposed development's sewer connection location, as well as the final alignment and profile of the relocated sewer and storm drain lines around the project site. The new roadway treatment will allow for the separation of surface drainage from the existing combined facility. The Proponent has reached agreements with all parties affected regarding the provision of such services.

Local storm drains that will be cut off or adversely impacted by the project will be revised and incorporated into the project storm drainage system. These areas include Bangs Alley, Kilby Place and portions of

PLANNED PROJECT AREA SEWER SYSTEMS



Central Court. The existing Kilby Street sewer system will be reconstructed to carry storm drainage from the revised street layout required for the development. This new storm drainage system will continue along Water Street, Broad Street, and Central Street to McKinley Square. This will allow for storm sewers of adjacent buildings to tie into this system, rather than being tied into existing combined sewerage.

Site Volume Impacts

Since the proposed site is presently covered by impervious surfaces, buildings and bituminous concrete pavement, the project will not generate any additional storm drainage volume. The existing site storm drainage is collected through roof leaders and catchbasins, and is discharged into the existing combined sewer systems servicing the site area. These collection systems will be removed during construction of the proposed development and will be replaced by new separated site drainage systems. These new systems will discharge into the new separated storm drain system (previously discussed) at discharge locations now under study.

The proposed project will generate increased volumes of sanitary sewage from that now being discharged from the site. The sanitary sewage generated by the proposed project has been projected at approximately 52,125 gallons per day (gpd). The calculation of this estimate is based upon standard sewage flow rates for various land uses as detailed in Title V of the Massachusetts Department of Environmental Quality Engineering Sanitary Code. Values used were 75 gpd/1000 SF of office space, and 5 gpd/1000 SF of retail space. These values are considered conservative (worst case) in determining flow, and are used to size critical building connections. Historical water use data obtained from BWSC indicates that the buildings presently on site consume water at the rate of 14,500 gpd. Assuming that the standard factor of 85 percent of supplied water is discharged as sanitary flow, the existing site contributes 12,325 gpd for a net increase in sanitary flow from the site of approximately 39,800 gpd.

Existing sewer connections from the site to the State Street sewer system will be abandoned. A new connection from the site will be required, and the

location is now under study. It has been determined in discussions with the BWSC that the existing combined sewer systems on State Street and Kilby Street are not adequate to accommodate the projected sanitary flows from the proposed project, and these systems have been ruled out as possible connection locations.

The project's sanitary sewer system is planned to connect into the existing 45-inch by 48-inch combined sewer line which runs from Broad Street beneath Central Street to McKinley Square where it connects to the East Side Interceptor (see Exhibits IV C-3 and IV C-4). The existing flows in, and the condition of this line will be studied in conjunction with the relocation of the existing sewer system around the proposed project site. This study will result in a determination of the capacity of this line to handle the flows from the project. It should be noted, however, that significant storm flows will be removed from this line as a result of the system revisions and separation to be undertaken as part of this project.

The information gained from this study will be available as part of the proponent's sewer study prepared for the BWSC, and before filing an application for a Massachusetts Sewer System Connection Permit which is required of all projects generating more than 2,000 gpd. The permit is reviewed jointly by BWSC and the Massachusetts Department of Environmental Quality Engineering--Division of Water Pollution Control. The purpose of the permit is to monitor types of discharge, prevent inadequacies in project design, and avoid overburdening of the public sewer system capacity. Submission of the Sewer Connection Permit application will include the locations and details of the project's sewers and drains, including the size, type, material, and elevation of all sanitary sewage drainage lines.

Mitigation Measures

As part of the ongoing review process with BWSC, the sewer system will be examined further by the consulting engineers. Regardless of the final details and system alignments adopted, a number of measures will be provided in order to ensure that the project does not contribute to pollution of Boston Harbor.

To help reduce the surcharged conditions in the East Side Interceptor and the Deer Island Treatment Plant, the combined sewer system to be relocated will be constructed as two separate lines; one to receive sanitary sewage generated on-site as well as combined sewage from combined sewers upstream, and one to receive stormwater.

When the project is completed, the new storm drainage system will collect storm flows not only from the project site, but from buildings along its route on Kilby Street, Water Street, Broad Street and Central Street. This will result in the removal of up to 4 acres from the contributing area to the existing combined sewer system. In addition, the new storm drainage system will be of sufficient capacity to facilitate separation of sanitary and storm flows from a total contributing area of up to 22 acres in the future when it is extended upstream of the project area by BWSC.

The Proponent is currently in discussion with the BWSC concerning requirements for the incorporation of a sewage holding tank within the proposed project. Such facilities are utilized to avoid contributing to existing surcharged conditions in the East Side Interceptor (ESI) during high-tide periods by holding sewage on-site until low-tide periods, at which time sewage is discharged into the sewer system by an automated pump system. Since ESI improvements designed to eliminate surcharged conditions may be completed by the date of occupancy of this project, it is possible that a holding tank may not be required. Current discussion with BWSC regards the elimination of this requirement, or alternately, the provision of a temporary holding tank. Since it is currently difficult to determine whether such ESI improvements will be completed within a schedule compatible with occupancy of the proposed development, a sewage holding tank designed to comply with all existing BWSC standards and specifications will be carried forward in the design of the project with the option that it will be deleted upon confirmation that ESI improvements will be completed prior to project occupancy.

A variety of other mitigation measures will be used to minimize adverse effects associated with sewage generation. Grease traps that meet Title V requirements will be provided at any restaurant kitchen facilities. Oil/

gasoline traps will be provided at the discharge point of the garage drainage system. These facilities will be maintained by project personnel and will meet the requirements specified by BWSC regulations. All wastewater facilities serving the project will be constructed in conformance with BWSC standards and specifications.

WATER SUPPLY SYSTEM

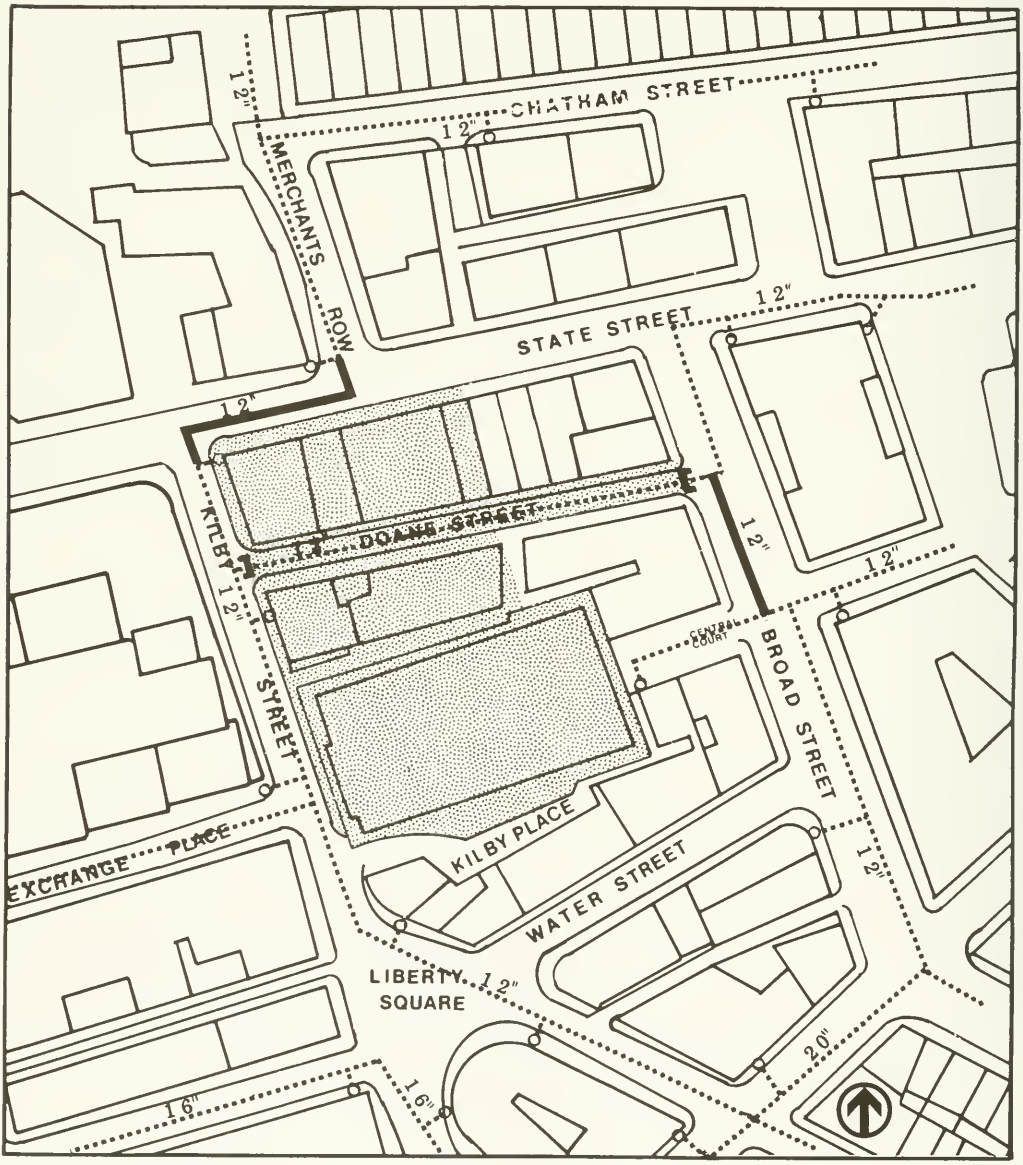
Existing Conditions

The existing water supply system for Downtown Boston is comprised of three separate systems, each designed to perform a different function. These systems are: High Pressure Fire Service (HPFS) lines which supply high pressure water to street hydrants (see Exhibit IV C-5); High Service (HS) lines which supply water for use in building fire protection systems (see Exhibit IV C-6); and Low Service (LS) lines which supply water for domestic use in buildings (see Exhibit IV C-7). Each of these systems exists in the site area and is described in detail below.

There are presently 2 HPFS loops that service the project area: One located in Batterymarch Street, Kilby Street, Exchange Place, Doane Street, Broad Street and State Street; the other in Broad Street and Central Street. These loops supply hydrants covering the existing site area located on Kilby Street, Doane Street and Central Street.

The High Service (HS) lines servicing the project area are located in State Street (12" and 8"), Broad Street (12"), and Merchants Row (12"). These lines supply water to fire protection systems in buildings along the above named streets.

The Low Service (LS) lines servicing the project area are located in Kilby Street (12"), State Street (16"), Doane Street (8"), Broad Street (8"), and Central Street (8"). These lines supply water for domestic use to the buildings within and adjacent to the proposed project site, as well as to low pressure street hydrants located on Doane Street and in Central Court.


CHATHAM STREET
MERCHANTS ROW
STATE STREET
DOANE STREET
KILBY STREET
CENTRAL COURT
BROAD STREET
KILBY PLACE
WATER STREET
EXCHANGE PLACE
LIBERTY SQUARE
12"
16"
20"
Existing Line
Proposed Line
Hydrant
1" = 100'

Probable Project Impacts

The proposed project requires the abandonment of the HPFS line in Doane Street to accommodate the proposed building foundation and below grade parking facility. The abandonment of this line would result in the creation of two "dead ended" HPFS systems, one running beneath State Street and Broad Street to Doane Street, and the other in Kilby Street from Exchange Place to State Street. However, loop service will be re-established for these systems (see Exhibit IV C-5) as described within the following section--Mitigation Measures. The project will also require the relocation of several HPFS street hydrants, but will not place any foreseeable increase in demand on the existing system.

The proposed project's impact on the HS system is limited to the additional demand that will be placed on the system to service the project. It is planned to limit the use of the HS water supply in the building to the fire protection system. This will restrict project demand on the system to emergency use only at the rate of approximately 1,500 gallons per minute. Preliminary discussions with BWSC indicate that this demand can be met within the capacity of the existing system.

The project requires the abandonment of the 8" LS waterline located in Doane Street to allow for the construction of the building foundation and a below grade parking facility. This line presently supplies water service to several buildings adjacent to the project site, as well as to a fire hydrant and buildings within the site to be demolished. Also, the proposed project will place an additional load on the existing LS water system to supply its domestic water needs. This additional demand, based on Title V standard criteria is projected at 44,300 gpd. This number is developed by factoring the projected sanitary sewage generation by the project and is summarized below:

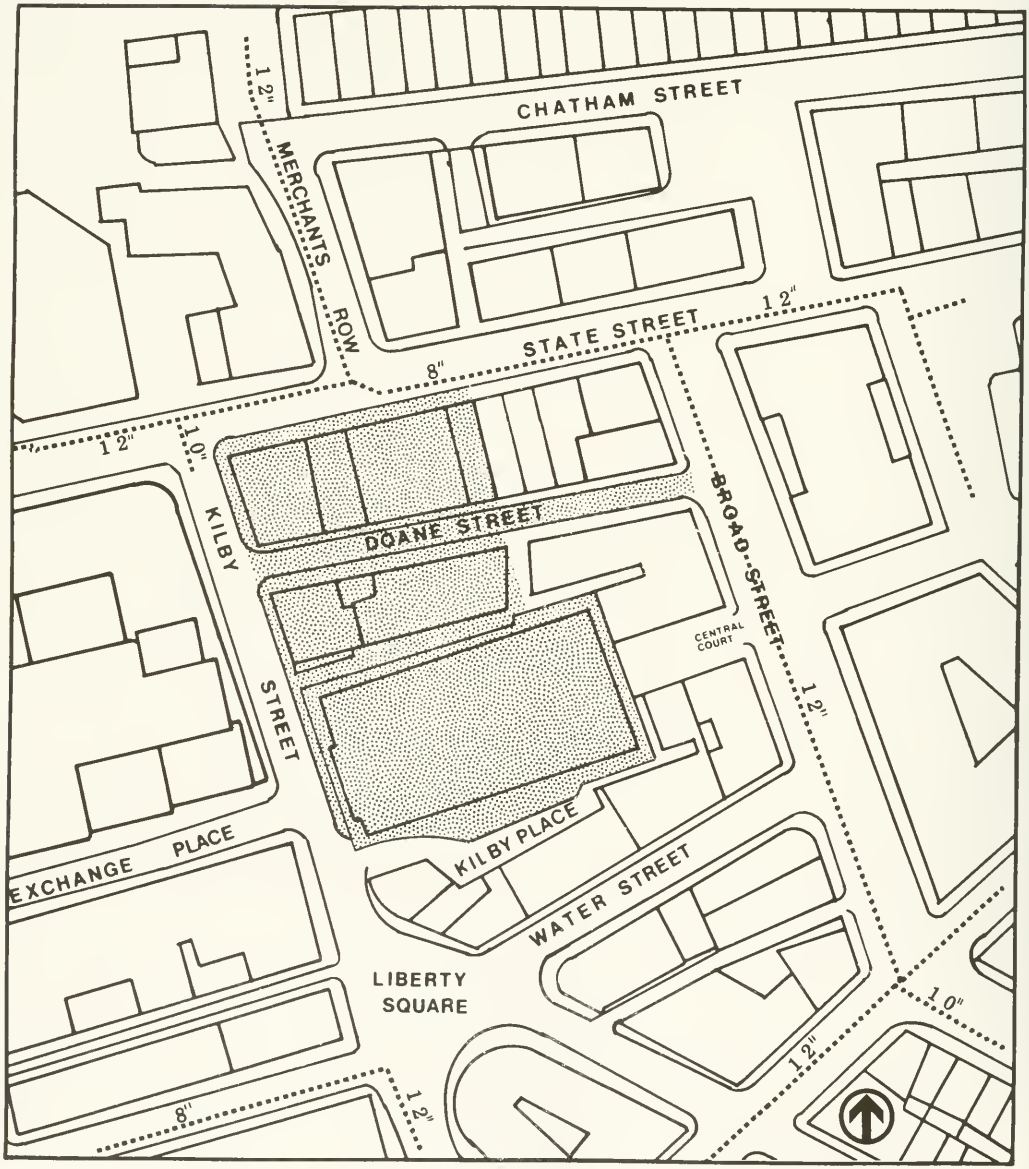
- Proposed Project:

  (52,125 gpd sanitary sewage flow) x (115%) = 58,800 gpd

- Existing Site:

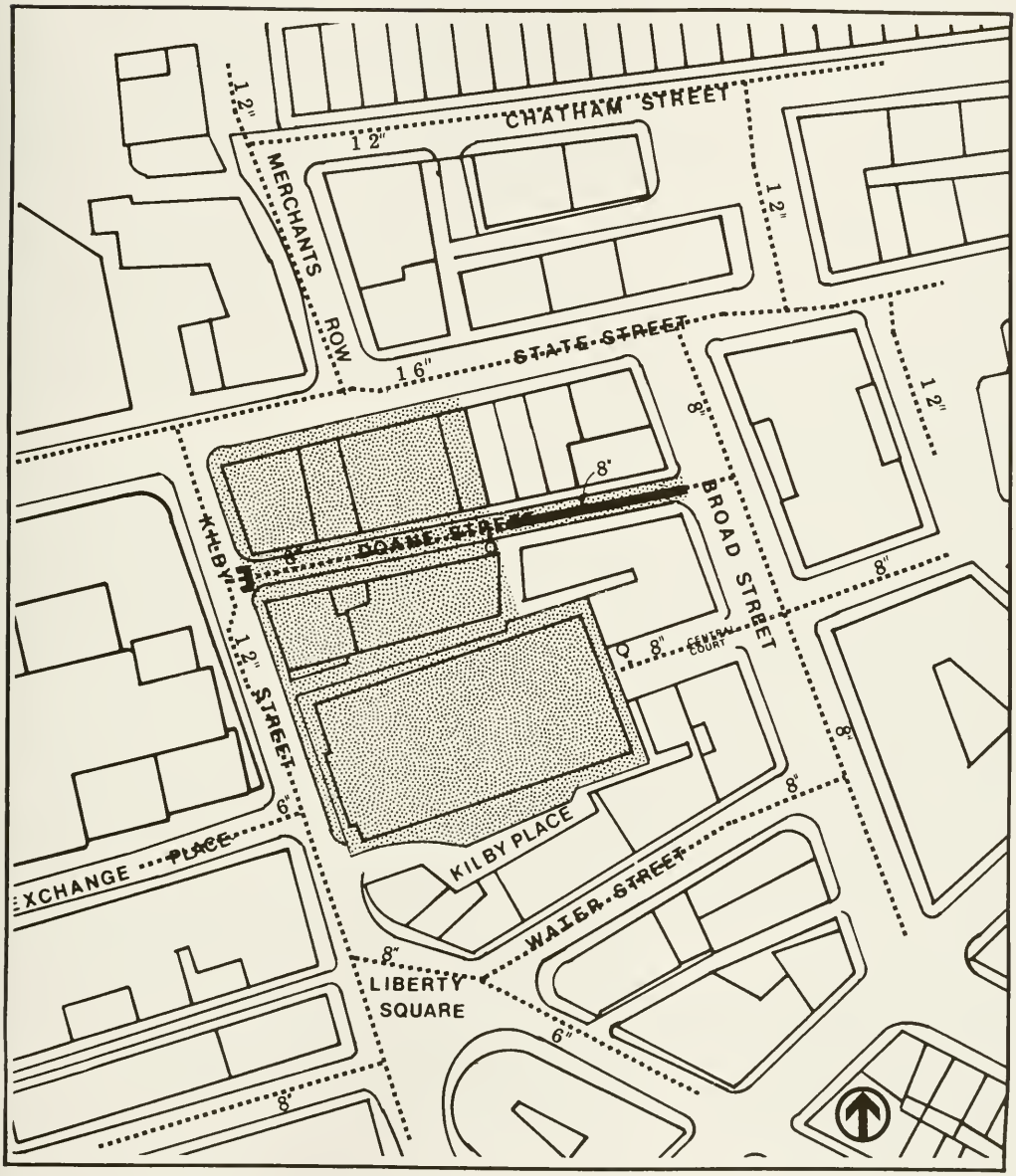
  From BWSC historical data = 14,500 gpd

- Increased Demand: 44,300 gpd



Existing Line

1" = 100'



Existing Line Proposed Line 1" = 100

This method of projection for demand is conservative in nature and gives a worst case average daily water useage figure. The air conditioning system for the development will be designed to limit the maximum make-up water volume to less than 7.5 gpm as required by BWSC. Initial discussions with the BWSC indicate that the existing LS water supply system in the project area is adequate to meet this increase in demand.

The Metropolitan District Commission (MDC) water supply system which services the Boston Metropolitan Region is presently carrying a demand of approximately 285 mgd. The maximum safe yield from the existing sources of water supply is estimated at approximately 300 mgd. The worst case of site water requirements projected above represents an increase of less than two hundredths of one percent in the estimated existing drawdown.

Mitigation Measures

As part of the site development for the proposed project, the HPFS lines dead ended by the abandonment of the line in Doane Street will be extended to interconnect to other systems, re-establishing loop service as required by BWSC (Exhibit IV C-5). The HPFS street hydrants requiring relocation due to project construction will be located so as to serve the site area to the satisfaction of the BWSC and the Boston Fire Department.

It is planned to reconstruct the LS water line in Doane Street, in conjunction with project construction, to allow for the required roadway modifications and to maintain service to the adjacent properties (see Exhibit IV C-7). Details for this work are being developed in cooperation with the BWSC and the property owners.

To minimize the amount of increased demand the project will be placing on the existing regional water supply, it is planned to use modern efficient plumbing fixtures within the project. These fixtures limit the use of water to up to 60% of the older standard fixtures.

Engineering for the system revisions described above is currently in progress, and is being conducted in conjunction with the BWSC and the City of Boston.

D Wind Conditions

INTRODUCTION

Wind tunnel testing of the proposed 99 State Street Project has been conducted in order to assess the possible effects of the proposed development on the ground-level pedestrian environment in and around the site. As was the case for past testing of previously considered design schemes, this analysis indicates that the proposed development will not cause pedestrian-level wind conditions to exceed wind guidelines established by the BRA.

METHODOLOGY

Testing Technique

All wind tunnel testing has been conducted at the Wright Brothers Memorial Wind Tunnel at MIT. Testing has utilized a 1:400 scale model of the project, and of all buildings and open spaces within a 1,600-foot radius of the site. Spires and roughness blocks were installed in the wind tunnel to simulate a wind profile characteristic of densely built urban areas such as the area surrounding the project site.

Testing at the wind tunnel has involved two different techniques. The Wind Erosion technique entails placing small particles throughout the model and observing their disturbance as a result of wind conditions. The Hot Wire technique entails placing short, thin electrical wires at key points throughout the model and monitoring the electrical current required to maintain the wire at a constant temperature during various wind conditions. The Wind Erosion technique yields qualitative data for the general site area, and was used to identify points at which wind effects may occur. These points were revised with the BRA staff, and a selection of locations for further study was made. The Hot Wire technique was then used to yield quantitative data regarding predicted pedestrian level wind speeds at these specific locations.

Wind Velocity Calculation

From hot-wire data collected at each location tested in the wind tunnel, three types of wind velocity information were recorded: the average velocity, the root mean square about the average (rms), and the peak two-second gust. Based on the rms and the average velocities, "effective gust" velocities (see definition

which follows) were then calculated. The average velocities, effective gust velocities, and peak gust velocities were then weighted on the basis of a statistical description of Boston wind conditions. These conditions were determined from wind roses compiled from seasonal and annual wind velocity direction and magnitude data collected over a 20-year period at Logan Airport. As a result of this weighting process, wind conditions in and around the site were predicted in terms of the following:

- o Hourly Average Velocity--fastest hourly average within a one hundred hour period.
- o Effective Gust Velocity--fastest one to two minute average within a one hundred hour period.
- o Peak Gust Velocity--fastest 2 to 3 second average within a one hundred hour period.

BRA Wind Guideline

In order to evaluate the pedestrian-level effects of wind velocities, the predicted velocities obtained from the wind tunnel analyses were evaluated with respect to the BRA wind guideline. Based upon the effective gust velocity, the BRA wind guideline has developed over a number of years through a series of wind tunnel tests conducted for specific sites in Boston. The guideline establishes a maximum effective gust velocity of 31 mph not to be exceeded more than one percent of the time.

Additional Criteria

For the purpose of producing a more conservative estimate of wind conditions, an additional step was undertaken in the analysis. In order to determine whether the average velocity, the effective gust, or the peak gust is the most critical determinant of windiness of a particular test station, the three velocities were converted to "equivalent averages" based on calculations using experimentally determined average relationships between the three. For each test station, the three velocity types can then be compared on the same scale. By utilizing for analysis the equivalent average velocity of greatest magnitude, a "worst case" scenario is produced for each test station.

Equivalent average velocities were utilized in evaluating pedestrian level wind conditions on the basis of

Melbourne's Criteria, an international standard developed by W. H. Melbourne. The extensive use of Melbourne's criteria in pedestrian-level wind speed analysis has set the precedent for evaluating the wind velocity data obtained from the hot-wire test conducted for the 99 State Street Project. Based upon a literature review of past studies and other wind comfort criteria, Melbourne developed a criteria for hourly average pedestrian-evel wind speeds defined by safety considerations and different types of human activity accommodated by each level of wind speed.

MELBOURNE'S CRITERIA FOR 100-HOUR
RETURN PERIOD VELOCITIES

CATEGORY			
Comfort Criteria		Equivalent Average (Uav) (mph)	Effective Gust (Uep) (mph)
1	Unacceptable/ Dangerous	$27 \leq Uav$	$39 \leq Uep$
2	Uncomfortable for Walking	$19 \leq Uav < 27$	$27 \leq Uep < 39$
3	Acceptable for Walking	$15 \leq Uav < 19$	$21 \leq Uep < 27$
4	Stationary Short Exposure	$12 \leq Uav < 15$	$16 \leq Uep < 21$
5	Stationary Long Exposure	$0 \leq Uav < 12$	$0 \leq Uep < 16$

Melbourne established five levels of human comfort criteria: unacceptable and dangerous, uncomfortable for walking, acceptable for walking, acceptable for short periods of standing ("short exposure"), and acceptable for long periods of standing or sitting ("long exposure"). A characteristic range of hourly average pedestrian-level wind speeds with a one percent probability of occurrence can be assigned to each criteria. The effective gust and equivalent average velocities for each of Melbourne's comfort criteria have been calculated and are presented in the accompanying table. In this analysis, equivalent average figures were utilized to classify wind conditions within Melbourne's categories in order to present a "worst case" scenario.

Previous Wind Testing

In addition to wind tunnel testing described in this section, wind analyses have been previously conducted in order to evaluate design schemes as part of the earlier design review process.

In the spring of 1985, an initial hot wire analysis was conducted to assess the effects of three design alternatives presented in the BRA Draft Environmental Assessment. This testing assessed the effects of alternatives ranging in height from 263 feet to 410 feet. The design of the middle alternative, at 395 feet in height, was most similar to the project design currently proposed. However, the current proposal utilizes an increased tower setback from Kilby Street.

Using the hot-wire technique and addressing sixteen test points surrounding the site, this previous analysis indicated that with any of the three project alternatives in place, all locations remained within the BRA guideline velocity, and no locations became "uncomfortable/dangerous" according to Melbourne criteria. Most locations remained within Melbourne's criteria levels for "comfortable for walking, stationary short exposure, and stationary long exposure."

Subsequently, a wind erosion analysis was conducted in order to refine locations of test points, and to add additional locations to be tested. On the basis of the wind erosion analysis, test point locations were then chosen for additional hot wire analysis after consultation with and concurrence of BRA staff.

Hot wire testing of the currently proposed design was based on these locations, as was analysis of the June 3, 1985 scheme which received earlier BRA Concept Approval. The June 3, 1985 scheme was characterized by similar height and overall massing as the currently proposed scheme, but with a tower setback from Kilby Street of approximately one-half of that of the current proposal. Analysis of this June 3, 1985 scheme indicated that at no stations would the BRA guideline be exceeded, and that no locations would become "uncomfortable/dangerous" according to Melbourne criteria.

The results of all hot wire testing of design alternatives other than the currently proposed project design is presented for purposes of comparison in Appendix D.

ANALYSIS OF PROPOSED DESIGN

Existing Conditions

Pedestrian-level wind conditions at 24 stations in the vicinity of the project site were studied in the hot-wire test, and are shown in Exhibit IV D-1. All of the stations utilized in the initial hot wire analysis were retested (see Appendix D), with the exception of stations 11, 12 and 14. Eleven new points were added, stations 17-27.

For existing conditions, these 24 stations were found to experience moderate pedestrian-level wind conditions. None of the stations tested exceed the BRA wind guideline.

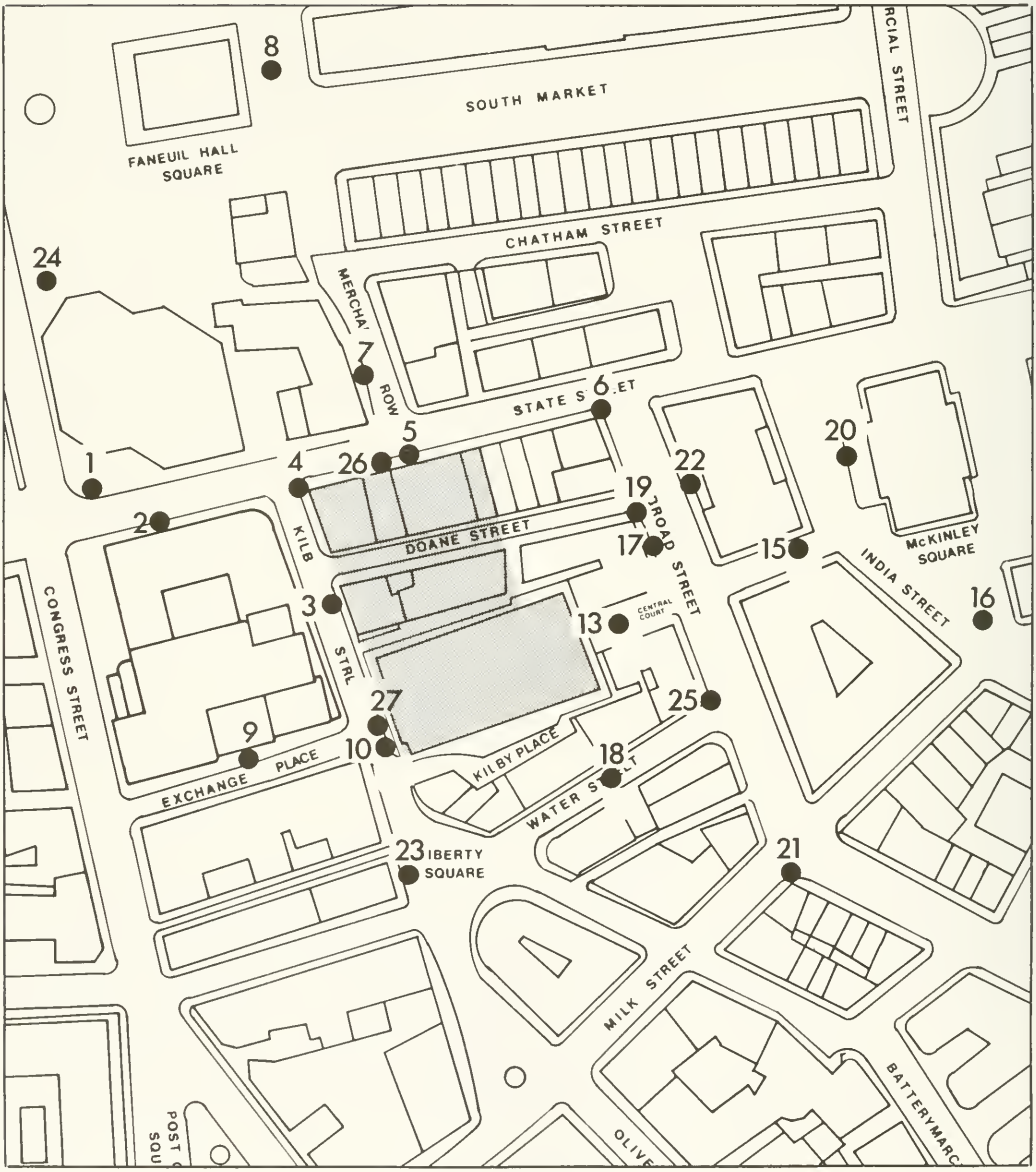
In terms of Melbourne's Criteria, as measured by equivalent average, the existing conditions can be categorized as follows:

Melbourne Category		Stations Tested
1	Unacceptable/Dangerous	None
2	Uncomfortable for Walking	2, 24
3	Acceptable for Walking	1, 4, 9, 10, 27
4	Stationary Short Exposure	3, 5, 6, 7, 15, 19, 20, 23
5	Stationary Long Exposure	8, 13, 16, 17, 18, 21, 22, 25, 26

Probable Project Impacts

The data evaluated from the hot-wire test for pedestrian-level winds in the vicinity of the project site has been used to compare changes between existing conditions and future conditions after proposed development. These changes have been described in terms of both effective gust and equivalent average. Based upon the data collected at the Wright Brothers Wind Tunnel, changes in velocity of greater than 0.6 mph are considered to be statistically insignificant. Therefore, pedestrian-level wind conditions at stations that experience a difference of less than 0.6 mph were considered to remain unchanged.

WIND STATIONS TESTED



IV D-6 Wind Conditions

Effective Gust

At no locations tested does the proposed development result in pedestrian-level wind conditions which exceed the BRA wind guideline, which establishes a maximum effective gust velocity of 31 mph.

In terms of effective gust, 11 stations experienced increased velocities, 4 stations experienced decreased velocities, and 9 stations remained unchanged. These changes are illustrated in Exhibit IV D-4. On the average, the predicted effective gust velocity increased by 0.44 mph over existing conditions.

Equivalent Average

In terms of equivalent average, 10 stations increased, 4 stations decreased, and 10 stations remained unchanged. These changes are illustrated in Exhibit IV D-5. On the average, the predicted equivalent average velocity increased by 0.38 mph over existing conditions.

Equivalent average velocities were utilized to classify predicted pedestrian-level wind conditions within Melbourne's comfort categories. As compared with the use of effective gust figures, equivalent average figures produce a more conservative "worst case" scenario.

As shown in the accompanying table, at no stations was Melbourne's category of "unacceptable/dangerous" found to exist. Most stations fell within Melbourne's criteria for "acceptable for walking, stationary short exposure and stationary long exposure."

At four stations (2, 9, 10, 24), Melbourne's "uncomfortable for walking" category applied. Two of these stations (2, 24) are relatively remote from the project, and were already in this category under existing conditions. These points were affected only slightly (1.0 mph and 0.2 mph respectively) by proposed development. The other two stations (9, 10), located near Exchange Place, were almost within this category under existing conditions, and were increased only slightly (1.4 mph and 1.8 mph respectively).

Exhibit IV D-2 WIND DATA SUMMARY TABLE

Test Points	Existing Conditions (MPH) Average	Peak	Effective Gust	Equivalent Average	Melbourne Category
1	17.1	32.0	24.9	17.4	3
2	20.9	33.5	28.0	20.9	2
3	12.2	23.9	18.3	12.8	4
4	18.1	32.7	25.5	18.1	3
5	14.1	27.7	20.1	14.1	4
6	11.0	25.7	16.7	12.8	4
7	13.8	26.2	20.0	14.0	4
8	11.2	22.8	16.1	11.4	5
9	18.9	29.5	24.7	18.9	3
10	17.8	27.1	22.8	17.8	3
13	7.4	18.6	11.7	9.3	5
15	11.6	24.6	17.1	12.3	4
16	7.4	23.3	12.8	11.7	5
17	10.0	22.4	14.6	11.2	5
18	4.7	13.1	7.9	6.6	5
19	11.9	23.8	17.3	12.1	4
20	12.1	23.6	18.1	12.7	4
21	10.0	22.3	15.1	11.1	5
22	7.2	18.1	11.7	9.0	5
23	14.0	27.4	20.9	14.6	4
24	20.5	31.9	26.6	20.5	2
25	8.6	21.7	13.7	10.9	5
26	8.3	22.5	13.4	11.3	5
27	17.8	25.7	22.3	17.8	3

Exhibit IV D-2 WIND DATA SUMMARY TABLE

Test Points	Proposed Development (MPH) Average	Peak	Effective Gust	Equivalent Average	Melbourne Category
1	17.1	32.4	24.4	17.1	3
2	21.9	34.0	29.0	21.9	2
3	16.3	26.6	21.5	16.3	3
4	15.2	31.2	22.9	16.0	3
5	13.8	27.5	20.1	14.0	4
6	9.9	25.5	16.6	12.8	4
7	12.5	25.1	19.0	13.3	4
8	12.1	23.4	17.0	12.1	4
9	20.3	29.5	25.5	20.3	2
10	19.6	27.1	24.0	19.6	2
13	9.4	18.8	13.4	9.4	5
15	11.4	24.1	16.8	12.0	4
16	7.6	22.9	13.2	11.4	5
17	11.8	25.2	17.0	12.6	4
18	8.9	18.9	13.0	9.4	5
19	14.6	25.8	19.6	14.6	4
20	11.1	22.4	16.4	11.4	5
21	10.2	23.6	15.7	11.8	5
22	7.4	20.7	12.3	10.4	5
23	9.1	22.5	14.7	11.3	5
24	20.7	32.4	26.7	20.7	2
25	10.2	22.4	15.3	11.2	5
26	9.7	22.3	14.5	11.2	5
27	17.6	26.0	22.2	17.6	3

These points have been categorized within Melbourne's criteria according to equivalent average velocity figures because such figures reflect worst-case conditions. However, if categorized according to effective gust figures, stations 9, 10 and 24 would be within category 3, "acceptable for walking."

Adjacent to station 10 (located within Kilby Street) is station 27 (located within the Kilby Street sidewalk). Although station 10 fell within Melbourne's "uncomfortable for walking" category, station 27 fell within Melbourne's "acceptable for walking" category. This indicates that wind conditions along the Kilby Street sidewalk may be considerably more comfortable than within the street itself.

Future conditions under proposed development are shown below as classified within Melbourne's categories according to equivalent average figures.

Melbourne Category		Stations Tested
1	Unacceptable/Dangerous	None
2	Uncomfortable for Walking	2, 9, 10, 24
3	Acceptable for Walking	1, 3, 4, 27
4	Stationary Short Exposure	5, 6, 7, 8, 15, 17, 19
5	Stationary Long Exposure	13, 16, 18, 20, 21, 22, 23, 25, 26

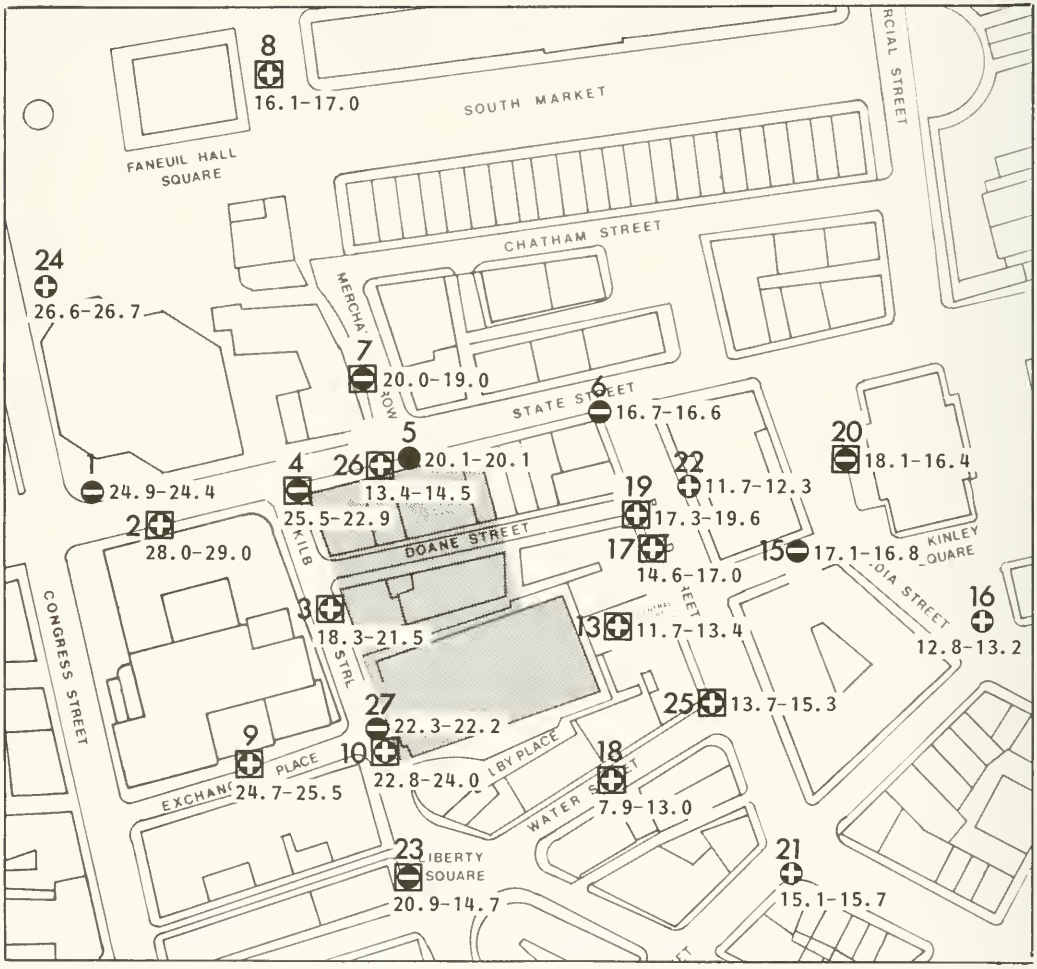
Comparison With Results of Previous Tests

Results of wind studies which have been previously conducted to assess the effects of design alternatives other than the scheme currently proposed are summarized in Appendix D. This information is presented for use in comparing effects of previously considered schemes with those of the currently proposed design.

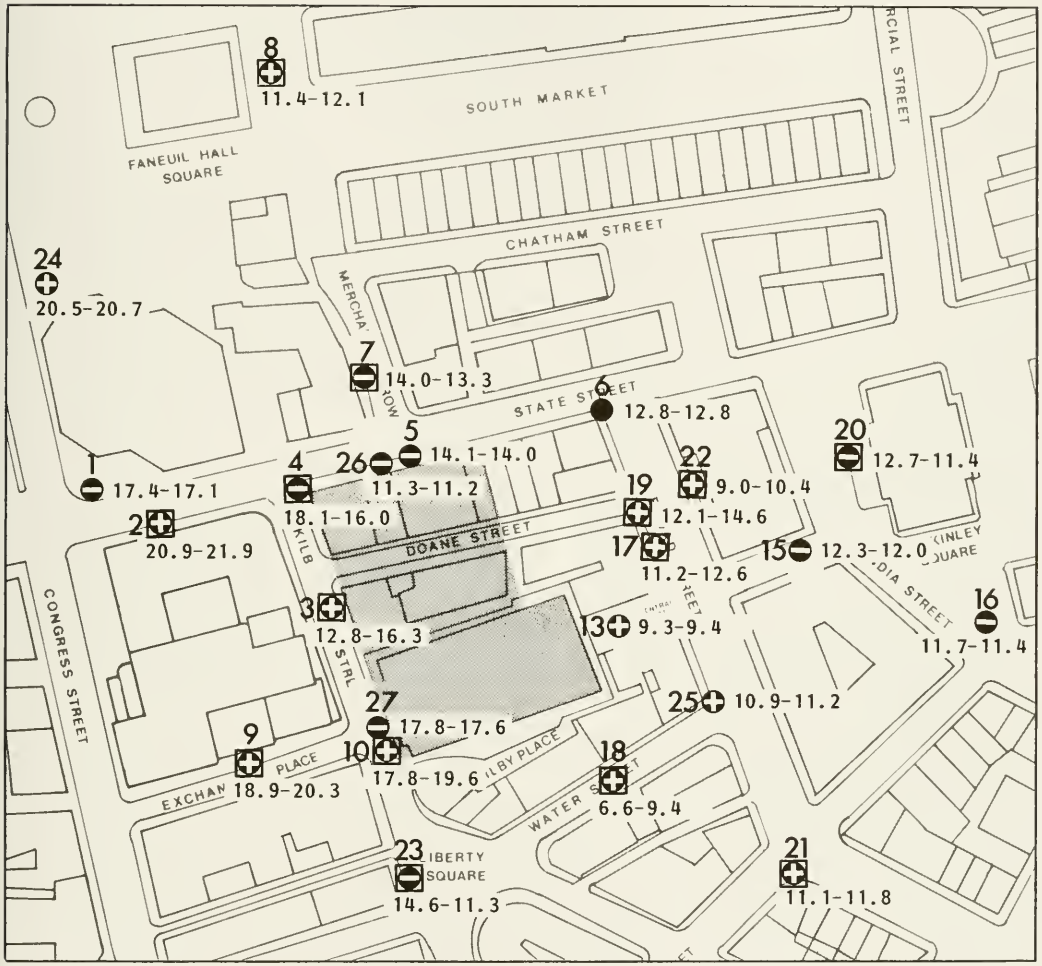
In summary, comparison of test results concerning previously considered variations of the currently proposed scheme indicates considerable consistency regarding expected wind conditions. None of the design

Exhibit IV D-3 CALCULATION OF CHANGES IN VELOCITY

Test Points	Effective Gust (MPH)			Equivalent Average (MPH)		
	Existing	Proposed Development	Change	Existing	Proposed Development	Change
1	24.9	24.4	-0.5	17.4	17.1	-0.3
2	28.0	29.0	+1.0	20.9	21.9	+1.0
3	18.3	21.5	+3.2	12.8	16.3	+3.5
4	25.5	22.9	-2.6	18.1	16.0	-2.1
5	20.1	20.1	0	14.1	14.0	-0.1
6	16.7	16.6	-0.1	12.8	12.8	0
7	20.0	19.0	-1.0	14.0	13.3	-0.7
8	16.1	17.0	+0.9	11.4	12.1	+0.7
9	24.7	25.5	+0.8	18.9	20.3	+1.4
10	22.8	24.0	+1.2	17.8	19.6	+1.8
13	11.7	13.4	+1.7	9.3	9.4	+0.1
15	17.1	16.8	-0.3	12.3	12.0	-0.3
16	12.8	13.2	+0.4	11.7	11.4	-0.3
17	14.6	17.0	+2.4	11.2	12.6	+1.4
18	7.9	13.0	+5.1	6.6	9.4	+2.8
19	17.3	19.6	+2.3	12.1	14.6	+2.5
20	18.1	16.4	-1.7	12.7	11.4	-1.3
21	15.1	15.7	+0.6	11.1	11.8	+0.7
22	11.7	12.3	+0.6	9.0	10.4	+1.4
23	20.9	14.7	-6.2	14.6	11.3	-3.3
24	26.6	26.7	+0.1	20.5	20.7	+0.2
25	13.7	15.3	+1.6	10.9	11.2	+0.3
26	13.4	14.5	+1.1	11.3	11.2	-0.1
27	22.3	22.2	-0.1	17.8	17.6	-0.2


8
16.1-17.0
SOUTH MARKET
FANEUIL HALL SQUARE
CHATHAM STREET
24
26.6-26.7
7
20.0-19.0
6
16.7-16.6
STATE STREET
5
20.1-20.1
4
25.5-22.9
26
13.4-14.5
1
24.9-24.4
2
28.0-29.0
DOANE STREET
22
11.7-12.3
19
17.3-19.6
20
18.1-16.4
17
14.6-17.0
15
17.1-16.8
KINLEY SQUARE
16
12.8-13.2
3
18.3-21.5
13
11.7-13.4
CONGRESS STREET
27
22.3-22.2
25
13.7-15.3
9
24.7-25.5
10
22.8-24.0
18
7.9-13.0
23
IBERTY SQUARE
20.9-14.7
21
15.1-15.7
Station Number
Test Point
Existing Velocity-Projected Velocity
Increase
Decrease
Statistically Significant Change

WIND CONDITIONS - EQUIVALENT AVERAGE



Station Number
● Test Point
Existing Velocity-Projected Velocity

⊕ Increase
⊖ Decrease
☐ Statistically Significant Change

alternatives previously tested resulted in pedestrian level wind conditions which exceed the BRA guideline, and none of the alternatives resulted in Melbourne's category of "unacceptable/ dangerous."

Seasonal Wind Data

Data regarding seasonal changes in wind velocities has been presented in Appendix C at the request of the BRA. In general, as compared to annual average velocities, predicted velocities are higher in Winter and Spring, lower in Summer, and approximately the same in Fall. It is also important to note that, at the 1% probability level, Spring winds are slightly greater than Winter winds. In addition, northwest winds dominate in the winter, southwest winds dominate in the summer, and storms with strong easterly winds usually occur in the Winter.

MITIGATION MEASURES

Analysis of the hot-wire wind tunnel tests suggests that wind conditions resulting from proposed development will, in general, comprise low-to-moderate pedestrian-level wind velocities which are consistent with comfortable pedestrian use of the area. During the design development process, the project's tower setback from Kilby Street was significantly increased, thereby mitigating wind effects in that area of the site.

E Shadow Conditions

INTRODUCTION

A series of computer-generated shadow analyses have been performed for the 99 State Street Project to predict and evaluate the extent of new project-generated shadows. This analysis indicates that, for the most part, the proposed development will not result in significant shadow effects in the vicinity of the project. The study area included approximately 45 blocks bounded by City Hall Plaza, Court Square, Franklin Street, the Waterfront and the intersection of Endicott Street and New Sudbury Street.

In addition to the shadow analysis outlined in this chapter, the Proponent has previously undertaken a more detailed analysis of shadow conditions within an important pedestrian-use zone located in the vicinity of the area between Faneuil Hall and the Central Quincy Market building. This analysis indicated that within this zone, known as the "Jugglers Area," no new shadows were created by proposed development during lunchtime peak use periods. During morning hours in late Fall and early Spring, some incremental shadow effects occurred in the Jugglers Area. A full report of this analysis can be found in the BRA Draft Environmental Assessment, May 1985.

Methodology

As agreed upon with the BRA, the shadow analysis presented here is based upon a design scheme originally presented as "Alternative 2" in the BRA Draft Environmental Assessment. This scheme utilizes the same general height and massing as the currently proposed scheme and, thus, can be expected to result in comparable shadow effects. For this analysis, shadows cast by the project were evaluated and compared to existing conditions. Shadow conditions are described in the following section and graphically portrayed in Exhibit IV E-1. Analyses were conducted for three times of day--9:00 AM, Noon and 3:00 PM--for the following days:

- March 21 (Vernal Equinox) averages shadow conditions equivalent to those on September 21, the Autumn Equinox)
- June 21 (Summer Solstice, minimum shadow conditions, conducted under daylight savings time conditions)

- o December 21 (Winter Solstice, maximum shadow conditions)

PROBABLE PROJECT IMPACTS

March 21 (Vernal Equinox)

- o 9:00 AM - As compared to existing conditions, the proposed building produces a new shadow at the entrance to 60 State Street in addition to producing a small area of new shadow over Congress Street north of State Street.
- o Noon - No new shadow.
- o 3:00 PM - As compared to existing conditions, the proposed building produces a small shadow to the south of Marketplace Center.

June 21, Summer Solstice

- o 9:00 AM - No new shadow.
- o Noon - As compared to existing conditions, the proposed project casts a shadow on the roof of its base element, and on a small portion of the sidewalk at the corner of Kilby and State Streets.
- o 3:00 PM - The proposed building casts a new shadow primarily on Broad Street and Central Street.

December 21, Winter Solstice

- o 9:00 AM - The proposed building produces an approximately 15 foot sliver of new shadow on Congress Street and the eastern most portion of City Hall Plaza.
- o Noon - No new shadow.
- o 3:00 PM - The proposed project casts a new shadow on a portion of Commercial Wharf.

CONCLUSIONS

The shadow analysis indicates that, for the most part, proposed development results in no significant additional shadow in the vicinity of the project. During

limited periods at various points in the project area, the proposed development was found to add only extremely small areas of increased shadow.

Shadow analysis has also been conducted for two previously considered alternatives, and is presented in Appendix E for purposes of comparison with the currently proposed scheme. This analysis can also be found in the BRA Draft Environmental Assessment for this project.

MITIGATION MEASURES

During the design development process for the 99 State Street Project, a number of measures were utilized in order to ensure minimal shadow effects to the surrounding area. These included:

- Use of a low-rise base element fronting State and Kilby Streets.
- Elimination of the 16-story Fiske Building fronting on State Street.
- Use of a high-rise tower element set well back from State Street.
- Doubling of the tower setback from Kilby Street compared with that which was originally proposed.

PROJECT AREA SHADOW CONDITIONS

Existing
March 21
9:00 am

Existing Shadow

Existing
March 21
12:00 noon

Existing Shadow

PROJECT AREA SHADOW CONDITIONS

Existing
March 21
3:00 pm

Existing Shadow

Exhibit IV E-1 PROJECT AREA SHADOW CONDITIONS

Existing
June 21
9:00 am

Existing Shadow

Exhibit IV E-1 PROJECT AREA SHADOW CONDITIONS

Existing
June 21
12:00 noon

Existing Shadow

Exhibit IV E-1 PROJECT AREA SHADOW CONDITIONS

Existing
June 21
3:00 pm

Existing Shadow

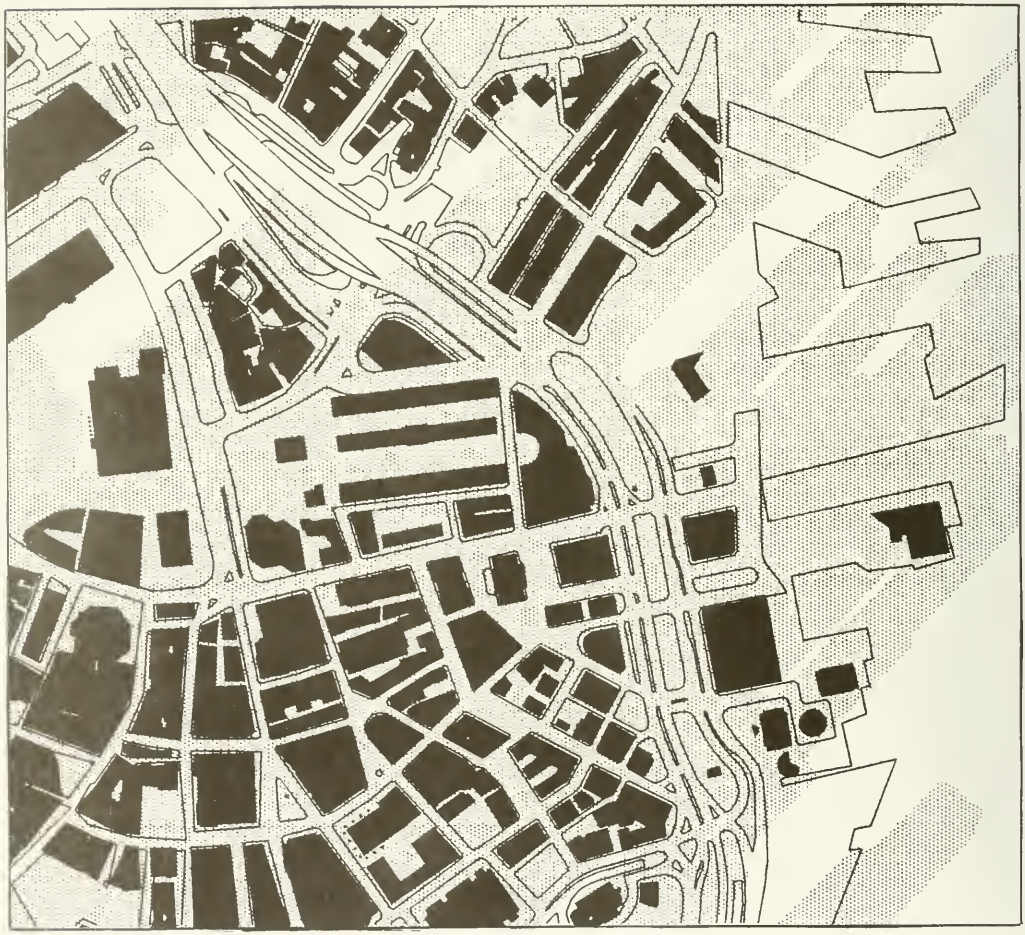
Existing
December 21
9:00 am

Existing Shadow

PROJECT AREA SHADOW CONDITIONS

Existing
December 21
12:00 noon

Existing Shadow



Existing
December 21
3:00 pm

Existing Shadow

PROJECT AREA SHADOW CONDITIONS

Proposed Development
March 21
9:00 am

Existing Shadow

New Shadow

PROJECT AREA SHADOW CONDITIONS

Proposed Development
March 21
12:00 noon

Existing Shadow

New Shadow

No new shadow

PROJECT AREA SHADOW CONDITIONS

Proposed Development
March 21
3:00 pm

Existing Shadow

New Shadow

Exhibit IV E-1 PROJECT AREA SHADOW CONDITIONS

Proposed Development
June 21
9:00 am

Existing Shadow

New Shadow

No new shadow

Exhibit IV E-1 PROJECT AREA SHADOW CONDITIONS

Proposed Development
June 21
12:00 noon

Existing Shadow

New Shadow

Exhibit IV E-1 PROJECT AREA SHADOW CONDITIONS

Proposed Development
June 21
3:00 pm

Existing Shadow

New Shadow

PROJECT AREA SHADOW CONDITIONS

Proposed Development
December 21
9:00 am

Existing Shadow

New Shadow

Exhibit IV E-1

PROJECT AREA SHADOW CONDITIONS

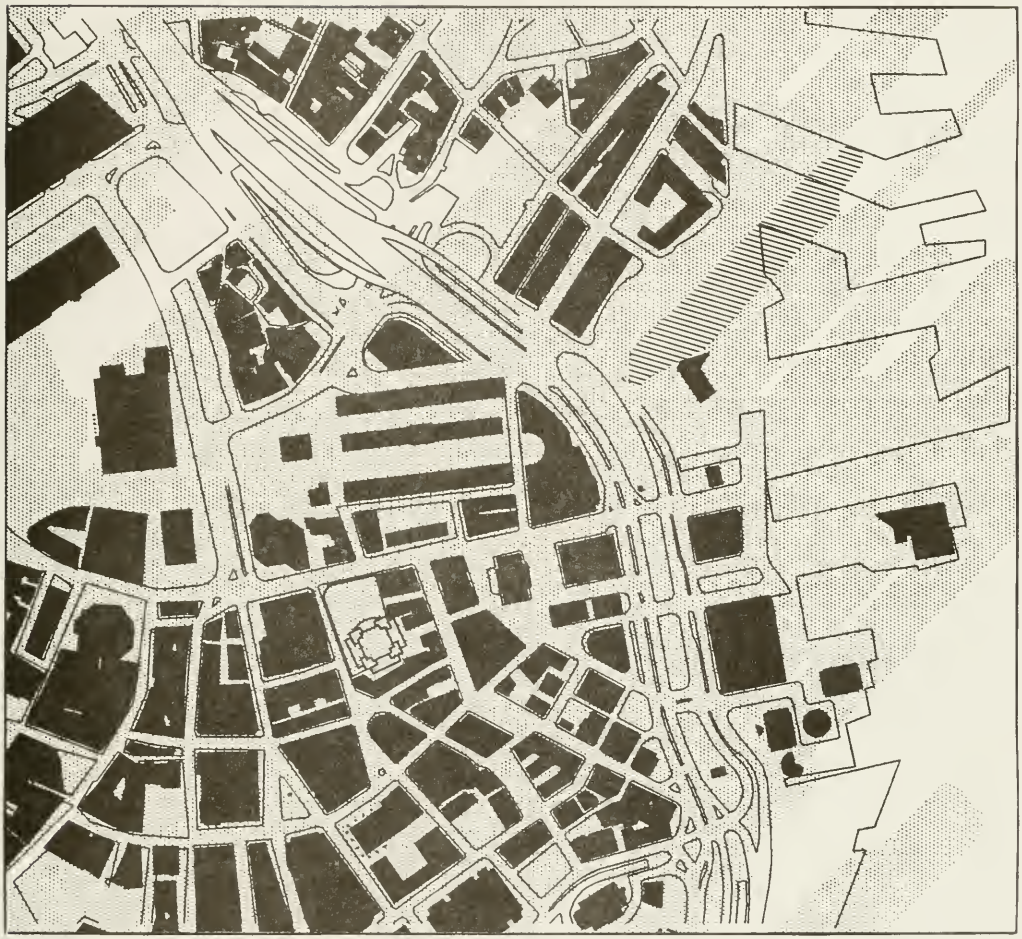
Proposed Development
December 21
12:00 noon

Existing Shadow

New Shadow

No new shadow

Exhibit IV E-1 PROJECT AREA SHADOW CONDITIONS



Proposed Development
December 21
3:00 pm

Existing Shadow

New Shadow

INTRODUCTION

This section discusses the consequences of the proposed undertaking with respect to the architectural/historic resources of the area. The contents include: a discussion of the historic setting; a description of existing conditions; a summary of the significance of historic resources in the vicinity; an assessment of the project's impact upon historic features; and identification of various mitigation measures. As discussed in the following text, analysis indicates that several structures and districts of historic significance are found in the area surrounding the site, that the architectural and historical significance of buildings currently on-site is negligible, and that the project will benefit nearby historic development in a number of ways. These include the maintenance of a low-rise cornice height along State and Kilby Streets, the creation of new views of the Custom House Tower and the establishment of pedestrian connections which reflect the area's history of through-block walkways.

HISTORIC SETTING

Origins

The project site stands at the eastern edge of the original Shawmut Peninsula shoreline, near the head of State Street, an historic artery which has connected Boston's waterfront to its commercial and mercantile core since the founding of the city. In Colonial times, the project area was a prominent commercial district, with an active waterfront as well as extensive residential development. The project area has retained its prominence and commercial vitality from its Colonial origins, through a major expansion in the Victorian and Edwardian eras, to the present day. A detailed history of the area can be found in Appendix A.

Surroundings

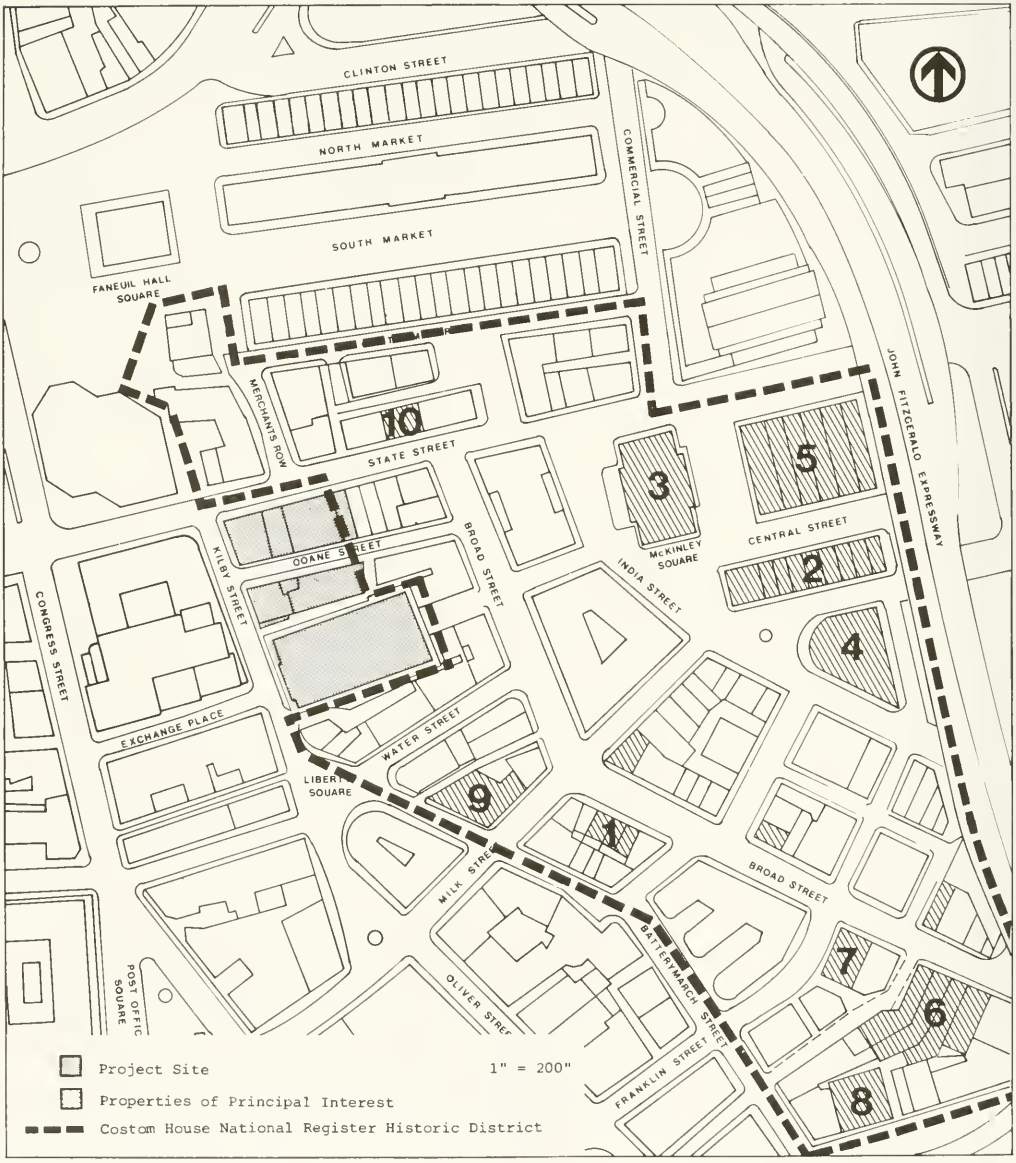
The immediate surroundings of the proposed project include nineteenth and twentieth century commercial structures to the south fronting on Liberty Square, to the east facing Broad Street, and on the north side of State Street. Two late twentieth century office towers also are nearby: Sixty State Street to the northwest and Exchange Place immediately to the west, the latter of which encompasses the preserved portion of the Old Boston Stock Exchange Building as well. It should be

Exhibit IV F-1

CUSTOM HOUSE NATIONAL REGISTER HISTORIC DISTRICT

Properties of Principal Interest:

1. Broad St. Associates Building
2. Central Wharf
3. Custom House
4. Flour and Grange Building
5. State St. Block
6. 50-54, 109-133 Broad
7. 99-101 Broad
8. Chadwick Lead Works
9. Formerly The Harvard Club
10. 114 State Street



noted that within the block of properties abutting the project site, the Proponent has acquired height and mass restrictions on 9 of the 13 buildings immediately to the east and south of the project. These covenants assure the preservation of the existing scale and character of the project area (see Exhibit IV F-9).

Within the immediate vicinity of the project site lie numerous noteworthy historic resources (see Exhibit IV F-2) including the following:

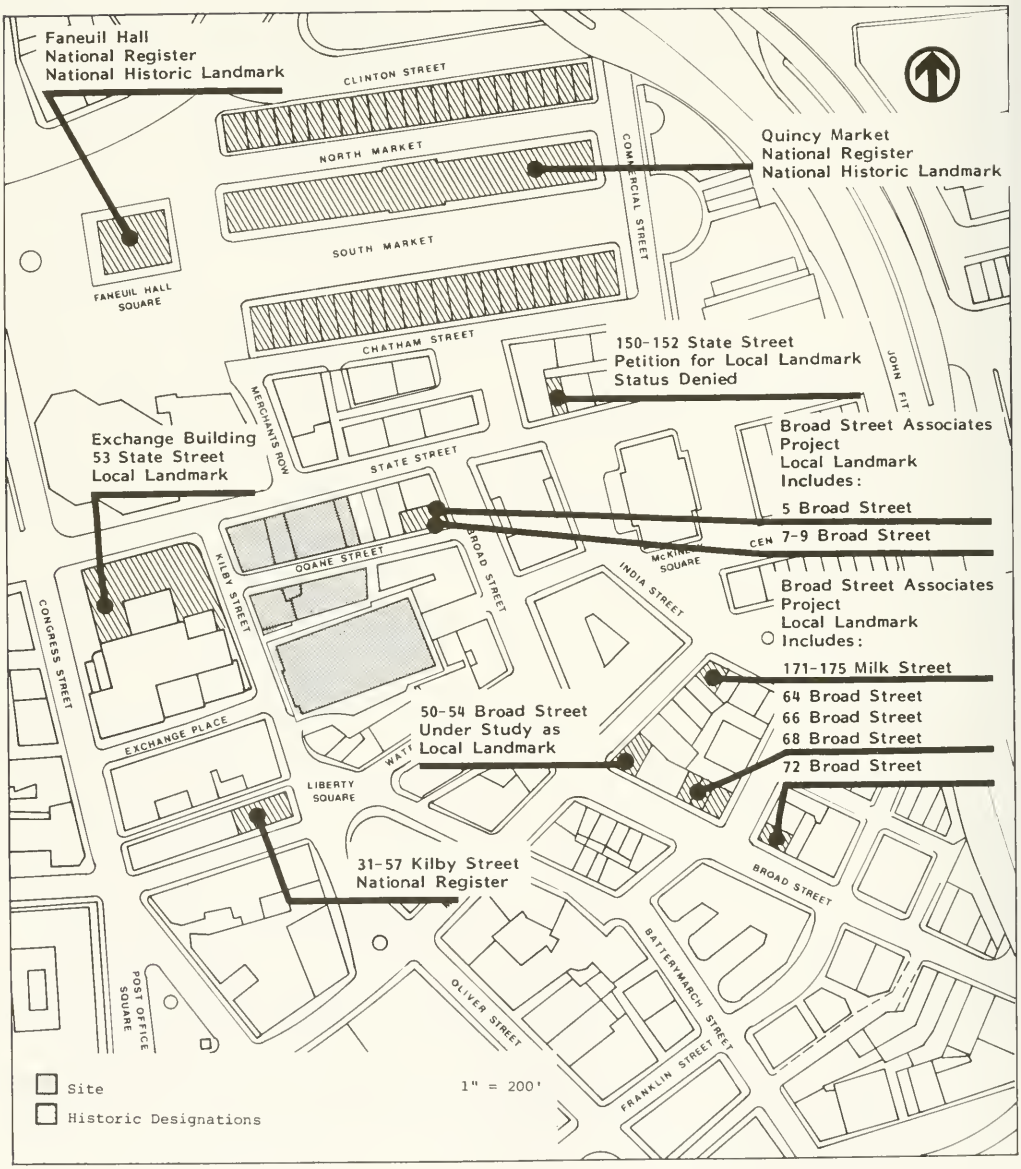
- Faneuil Hall Market District, to the north, is a six-acre auto-free zone encompassing Faneuil Hall, a National Historic Landmark designed by John Smibert in 1742 and enlarged by Charles Bulfinch in 1808, as well as three National Register properties designed in the Greek Revival style by Alexander Parris in 1824-26, the central "Quincy Market" building, and the flanking North and South market buildings. These former mercantile structures were recycled in 1968-75 and now enjoy international acclaim as a specialty retail, entertainment and commercial office development of enormous vitality and popularity.

- The Old State House is at the head of the State Street intersection with Congress Street, which is also the locus of the Boston Massacre. Built as the seat of pre-revolutionary government in Massachusetts in 1711, the Old State House was reconstructed in brick in 1747 after a fire. The Old State House now houses the collections and exhibits of the Bostonian Society. It is a National Historic Landmark and a popular stop for tourists along the Freedom Trail, a self-guided walking tour of central Boston's major 18th and 19th century landmarks.

- The Custom House National Register Historic District to the east comprises approximately 16 acres of mixed commercial architecture reflecting Boston's development as a major mercantile city, including a number of noteworthy structures depicted on Exhibit IV F-1. These include the Custom House itself, Central Wharf, the Grain and Flour Exchange, as well as several surviving Bulfinch buildings. The District is an architectural environment of great heterogeneity in form, scale,

Exhibit IV F-2

HISTORIC DESIGNATIONS IN PROJECT AREA
(See also Custom House District Map)



materials and style, representing development from the beginning of the nineteenth century through the early twentieth century.

- Liberty Square, to the south, contains a number of noteworthy late nineteenth and early twentieth century buildings, several of which have been recently renovated.

Site

A number of conditions exist within the project site which lessen the quality of the area's pedestrian environment, and which detract from the historic character of nearby development. These conditions include the presense of unattractive parking facilities atgrade and within the Kilby Street Garage, poor maintenance and extensive litter along Doane Street and Kilby Place, the presence of a photographic kiosk at the corner of State Street and Kilby Street, and inconsistent and unattractive street frontage along State Street and Kilby Street.

Existing structures on the site include:

- 75 State Street, a surface parking lot containing a small photo-processing outlet.

- 83-85 State Street, circa 1920, a five-story, fourbay commercial building which has been substantially altered at its storefront level.

- 89 State Street (the Fiske Building), circa 1888, a massive sixteen-story granite-faced Romanesque office building by Peabody and Stearns, whose dominant tower was removed along with portions of the original cornice and projecting detail in 1964, when it was refaced in aluminum and glass curtain wall concurrent with the addition of five contemporary stories in place of the former tower (see Exhibit IV F-3).

- 97-99 State Street (the Fiske Annex), circa 1903, a slender, five-story commercial structure of broad glass bands surrounded by masonry with classical revival decoration and a new storefront, circa 1980 (see Exhibit IV F-5).

- 5-23 Doane Street, circa 1919, a seven-story commercial building.

- 14-20 Kilby Street, circa 1922, a late example of Second Renaissance Revival style common to Boston's commercial architecture erected as a nine-story addition to its abutter, the aforementioned 5-23 Doane Street Building.

- 30-36 Kilby Street, a mid-twentieth century parking garage owned by the City of Boston.

Significance of Structures on Site

The architectural and historical significance of the previously listed properties on site is discussed here in accordance with recognized evaluative criteria, including eligibility for listing in the National Register of Historic Places and suitability for designation by the Boston Landmarks Commission as Local Landmarks or as contributory to a Local Landmark District.

With respect to Local Landmark status, the findings of the professional survey team organized by the Boston Landmarks Commission to undertake its Central Business District Survey rated all structures within the footprint of the proposed development as Group V, "Minor Significance". This category is reserved for properties which have little individual historical or architectural significance, are vernacular works or have been substantially altered, and/or make a minor contribution to the overall context and streetscape of the central city. The Commission also rated the garage at 30-36 Kilby Street a Group VI, indicating no preservation significance for this property.

Subsequently, the rating of one property in the proposed project area was adjusted by the Boston Landmarks Commission. The former Fiske Building at 89 State Street was assigned to a newly-created category: "Group III - Further Study". This new rating was intended to identify the need for additional information in order to properly evaluate the relative significance of a property which might merit Group III standing. (Group III buildings are those which appear to meet the criteria for Landmark designation and individual listing in the National Register of Historic

Places.) The Commission's action, which was one of a series of such adjustments arising from its review of the entire CBD Survey, occurred in May 1983, after consideration of public comments and staff recommendations regarding its consultant's findings. Discussions with several Commissioners and BLC staff members underscored their uncertainty about the condition of extant portions of the Fiske Building and the relative significance of such surviving elements in their present altered state.

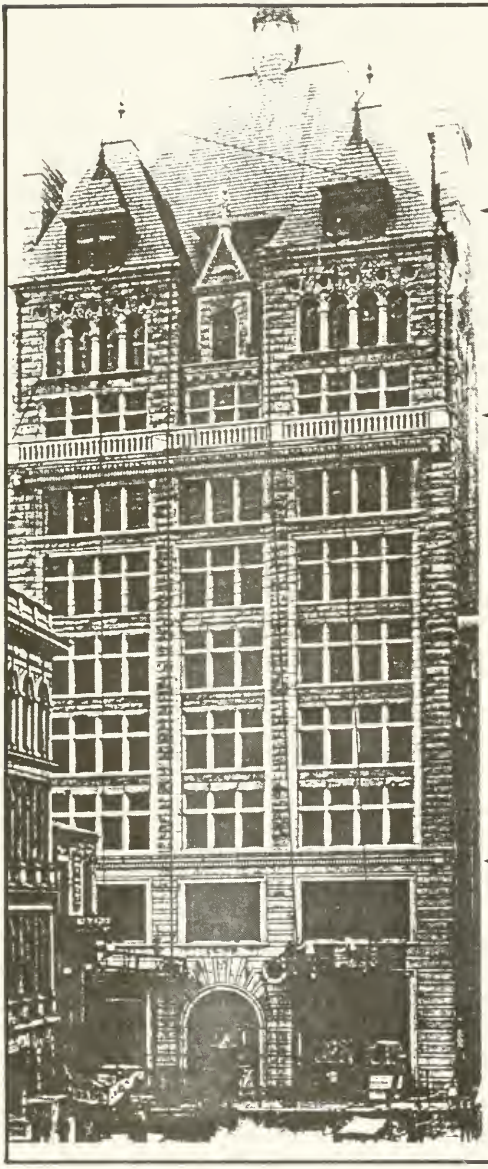
Findings of the Proponent's research program concerning the extent and condition of original building fabric presently concealed behind a contemporary curtain wall facade at 89 State Street is presented in the following section. Ongoing contact and consultation with the Boston Landmarks Commission will be continued in order to satisfy any further need for documentation regarding the condition and alteration of this building.

With one exception, properties within the site area are not considered eligible for individual listing in the National Register of Historic Places by the Massachusetts Historical Commission or by the Boston Landmarks Commission. One structure within the site area, 97-99 State Street, is listed in the National Register of Historic Places by virtue of its contribution to the Custom House Historic District, rather than on the basis of the building's own special significance (see Exhibit IV F-5). The rationale for this listing, its consequences for the project and the merits of retention of this structure are discussed in a following section.

Fiske Building (89 State Street)

A program of research and investigation into the question of the significance of the remaining portions of the Fiske Building has been conducted by the Proponent. The effort has included historical research focusing on obtaining narrative or illustrative material about the building's original appearance and construction, and technical evaluation of the current condition of the remaining portions of the building's facade by gaining access at selected points to the space between the original wall and its later enclosure.

Original Condition



ENTIRE ROOF, TURRETS, DORMERS & FRAMING DEMOLISHED FOR NEW OFFICE PENTHOUSE.

PART OF CHIMNEY SURVIVES.

MASONRY FACADE SEVERELY ALTERED TO ENLARGE WINDOWS.

PROJECTING BALCONY REMOVED FOR NEW CURTAIN WALL.

ALL WINDOWS REPLACED.

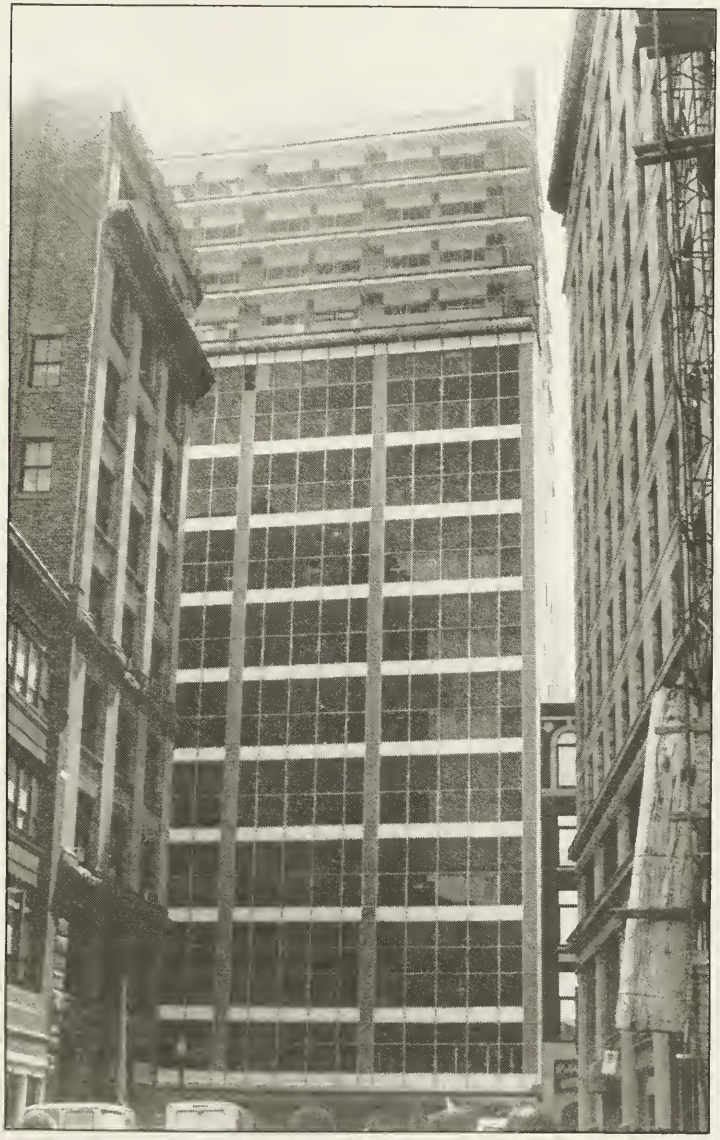
CENTER PORTION OF FRONT FACADE IS SUBSTANTIALLY INTACT, ALTHOUGH THE NEW CURTAIN WALL ANCHORAGES HAVE CAUSED SOME MASONRY DAMAGE.

PROJECTING CORNICE CUT BACK.

STOREFRONTS PARTIALLY REMOVED & MASONRY ENFRAMEMENTS SUBSTANTIALLY ALTERED; SOME ORIGINAL MATERIAL SURVIVES.

Exhibit IV F-3 FISKE BUILDING ANALYSIS:

Existing



Methodology for the historical research included inquiries to recognized scholars studying the work of Peabody and Stearns, as well as a systematic search of all known local and regional archives for drawings, correspondence or illustrated publications concerning the Fiske Building. This research resulted in the discovery of a portion of Peabody and Stearns original drawings of the Fiske Building in the collection of the Print Department of the Boston Public Library. The drawings consist primarily of interior plans, interior elevations and details for public spaces. These drawings, as well as historic photographs of the building, have been used in this analysis to compare the structure's original condition with that of the altered structure which exists today.

This historical research has confirmed several important facts bearing upon the significance of the property:

- The architects were Peabody and Stearns, an important Boston firm at the turn of the century whose notable works include Mathews Hall and Hemenway Gymnasium at Harvard, the Exchange Building and the old Museum of Fine Arts at Copley Square.

- The original owner of the building was Joseph N. Fiske, a prosperous dry goods merchant and later a successful stock broker.

- The contractor was the Norcross Brothers, builders reknowned for their collaborations with architect H.H. Richardson on numerous projects including Trinity Church and the Grain Exchange. The Norcross quarries in Worcester may well have furnished the granite and sandstone used in the Fiske Building.

- The structure was erected in 1888-1889, for total cost of $480,000.

- The Fiske Building's steeply pitched Chateauesque roof was welcomed in the press upon its construction as a major landmark in Boston's financial district and later called "Boston's first skyscraper", although that honor is most often reserved for Clarence Blackall's 1894 steel frame building on Washington Street and/or the Peabody & Stearns' Customs House Tower addition of 1913.

In addition to historical research, a physical survey of the condition of the Fiske Building has been conducted, including an examination of the structure's remaining facade elements beneath the existing curtain wall. Comparative analysis of photographs of the Fiske Building, both before and after alteration (see Exhibit IV F-3) suggest the extent of the 1964 losses. The picturesque roofscape of the structure was removed in its entirety, including the highly articulated turrets and dormers, the roof surface and all structural framing. In addition, portions of the original cornice and some projecting detail were removed in order to accommodate conventional clearances for the new curtain wall. Little information is available about the extent and dates of storefront alterations. Original finishes and details, as depicted in original Peabody & Stearns drawings for the building, no longer exist within the interior of the building, having been removed or drastically altered.

The technical assessment of the condition of the original masonry facade beneath the 1964 wall panels has revealed masonry damage caused by curtain wall anchorage and alteration to some of the window enframements, as well as various storefront interventions. The general conditions encountered were of unarticulated masonry lacking in significant incised relief, projecting detail, elaborate jointing or coloration. These findings have been illustrated by annotating a turn-of-the-century photograph of the Fiske Building (see Exhibit IV F-3), and by including a photograph of typical curtain wall attachment to the surviving facade (see Exhibit IV F-4).

On the basis of such information regarding the extent of alteration to this building, it appears that its current architectural significance is minimal. The surviving portions of the principal facade reveal little of the styling which characterized and distinguished the original base and top of the structure. Its retention would not evoke the qualities for which the Fiske Building, in its unaltered form, was valued.

97-99 State Street

The "Fiske Annex" at 97-99 State Street (1903) is located within the northwest periphery of the Custom House Historic District (see Exhibit IV F-5). It was

Detail of typical curtain wall anchorage at rusticated masonry pilaster (third floor of Fiske Building), showing metal clip, embedded faster, and fractured cornice above.

not mentioned in the National Register District nomination form, which cites a number of major structures in the District. It is probable that the building is not eligible for individual listing, but rather plays a minor contributory role in the District. This assessment is corroborated by the Boston Landmarks Commission survey of the area, which rated the property in Group V ("minor significance"), a category reserved for vernacular, undistinguished or altered buildings meriting limited protection.

The aforementioned nomination form characterizes the Custom House Historic District as "an architectural environment of great heterogeneity in form, scale, material and styles". It is within this diverse architectural context that the contribution of the Fiske Annex must be determined and its relative significance assessed. The slender five-story commercial building lacks any significant interior detail of merit. Also, the ground floor exterior has been substantially altered, circa 1980. Accordingly, the assessment of the building's contribution to the District must focus on the upper story facade, the surviving historical element.

The facade of 97-99 State Street consists of a sparsely articulated masonry surround which enframes four broad bands of clear glass. The style is transitional, moving from the expressed bay structure characteristic of much of the District to a tentative exploration of the more contemporary curtain wall style later refined by the Chicago school of early twentieth century architects. Overall, the building is of compatible scale with its easterly abutters in the District and roughly contemporaneous with them as well. However, its style is less exhuberant than that of other buildings in the District. On balance, the architectural and historical contribution of this structure to the Custom House Historic District appears negligible. However, the continuity of height and materials which it exemplifies are historically significant principles and important urban design parameters for any proposed replacement structure on the site.

The proponent has carefully considered the possibilities for retention of the entire Fiske Annex Building or its facade, and the prospects for successful integration of these elements into the overall design.

99 STATE STREET

Numerous technical obstacles are posed by this approach, including: markedly disparate floor elevations; the structural inadequacy and flammability of the present floor and roof construction; the difficulty of achieving proper bracing for necessary excavation behind the facade support line in order to create the necessary below grade parking and service spaces; and the inability of the structure at grade to be altered in a manner likely to reinforce the overall project goals for enhancing the pedestrian circulation through the block. Moreover, it appears that the retention of a facade of minor significance, which disrupts the circulation objectives and design compatibility of the overall project, would be less beneficial to the public than the proposed design itself.

As a result, it has been concluded that the retention of the Fiske Annex Building or of its facade are both economically and technically infeasible. In this case, it is believed that the retention and incorporation of building fragments of modest distinction within this new development would represent minimal architectural merit. However, the loss of the Fiske Annex Building will be mitigated by the achievement of a variety of desirable urban design objectives, including an overall beneficial effect on other, more distinguished, historic properties in the vicinity. The Fiske Annex Building will be replaced by a low-rise commercial structure consistent with nearby historic development in terms of materials, scale, fenestration and facade articulation.

PROBABLE PROJECT IMPACTS

Primary Impacts

Any potential primary impacts of the proposed development upon historic resources would result from new construction on a site partially occupied by existing buildings, and from construction procedures to be used to create the foundations and the below-grade parking structure of the proposed project. At issue is whether these activities have a direct effect on historic resources. Primary impacts consist of the demolition of six existing buildings on site. Five of these lack standing as historic resources warranting retention. The 99 State Street Building is within the Custom House Historic District, but has not been noted for special significance. Retention appears neither desirable nor

feasible, in light of the overall goals of the project for pedestrian circulation, massing and design compatibility.

Secondary Impacts

The project is anticipated to have secondary effects on its historic surroundings as follows:

- The maintenance of a consistent low-rise cornice height along both State Street and Kilby Street and the use of a setback tower above has a beneficial effect on the streetscape and upon the enduring scale of adjacent historic resources to remain (see Exhibit IV F-6). This includes a reduction in cornice height at 89 State Street, 20 Kilby Street and the Kilby Street Garage.

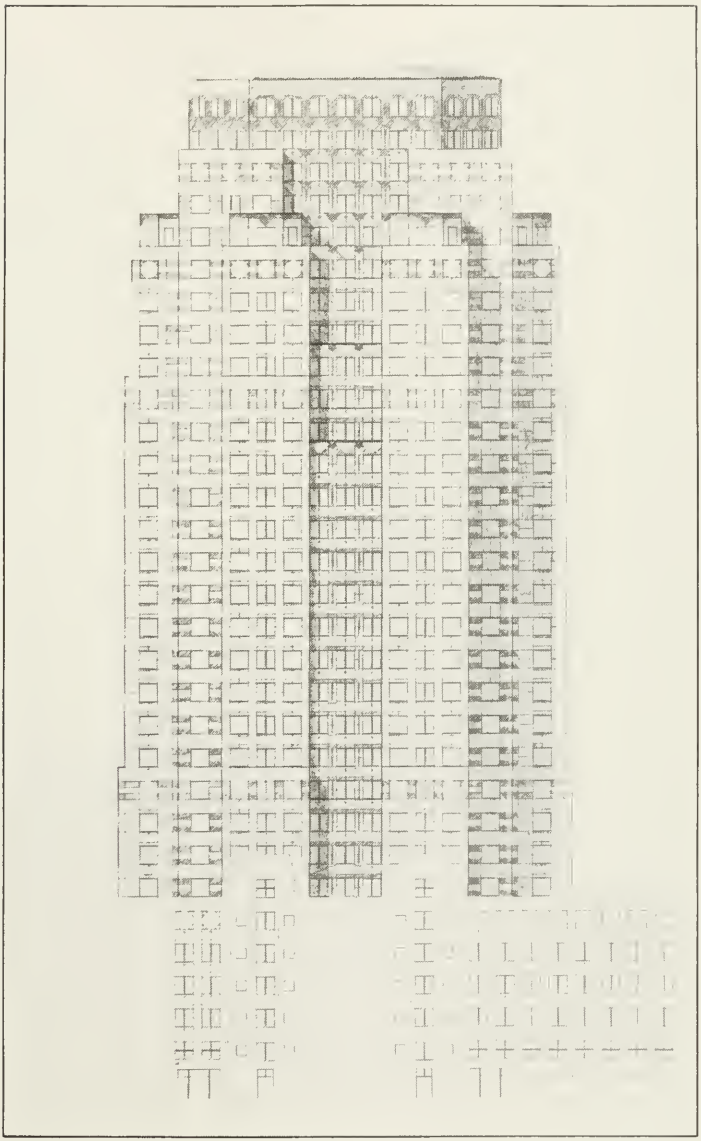
- Views and vistas of surrounding historic structures will be improved as a result of the massing of the proposed development. The prominence of the major vertical historic feature in the vicinity, the Custom House Tower, will be greatly enhanced from the heavily-travelled intersection at State and Congress Streets by the project. As shown in Exhibit IV F-7, the proposed development opens up this scenic vista, which is of considerable importance to the historic and contemporary relationship between the Custom House Historic District and the locus of the Old State House.

- Pedestrian circulation to and from historic properties and streetscapes in the vicinity will be improved. Central Street Court, and the State and Kilby Street sidewalks immediately adjacent to the Project, will be reconstructed and upgraded in materials compatible with and of the same quality as those used elsewhere in the Project.

  Also, Merchants Row, a major pedestrian corridor from the financial district to Quincy Market, will be upgraded. Plans for physical improvement of Merchants Row are currently being developed in conjunction with the BRA. The objective of such improvements is to create a pedestrian-oriented streetscape within Merchants Row so that its function as a gateway to the Faneuil Hall Marketplace will be strengthened.

Exhibit IV F-6

STATE STREET ELEVATION



1" = approx. 54'

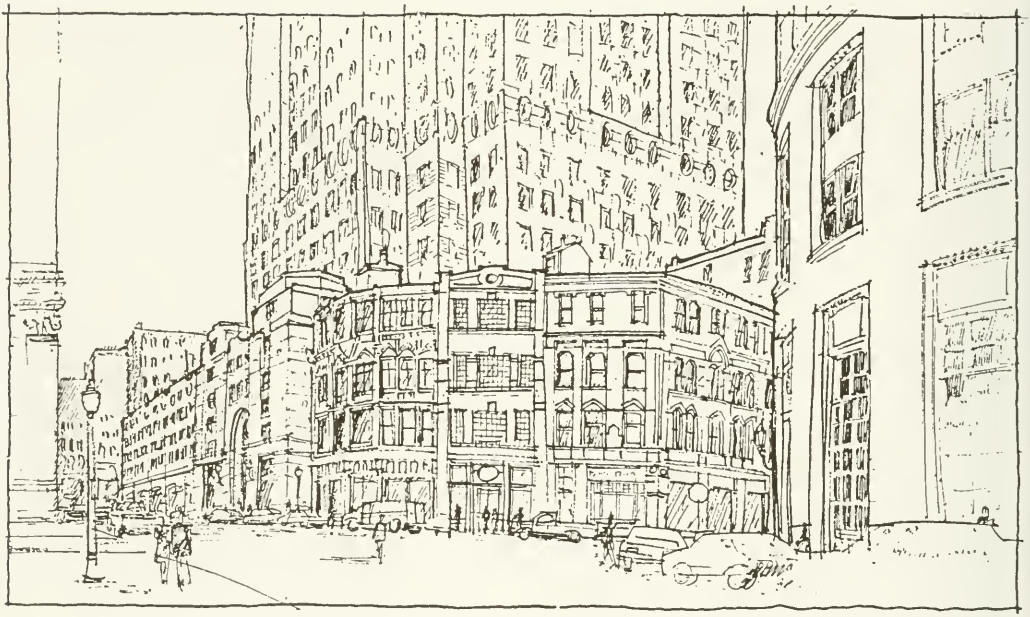
VIEW OF STATE STREET FROM CONGRESS STREET

Existing

Exhibit IV F-7 VIEW OF STATE STREET FROM CONGRESS STREET

Proposed

Exhibit IV F-8 VIEW FROM LIBERTY SQUARE



In order to achieve this objective, materials utilized in the plaza areas of the Faneuil Hall Marketplace will be extended and incorporated within Merchants Row. Such materials are expected to include brick, granite, lighting and other treatments conducive to the desired pedestrian orientation for this area. Such improvements will be implemented consistent with vehicular and servicing requirements associated with Merchants Row. The unification of pedestrian circulation to and through the proposed project via Merchants Row, Central Street and Exchange Place is a highly desirable effect of the development.

- As shown in Exhibit IV F-8, the project's tower and low-rise base will be visible from the southerly portions of Liberty Square and the approach to Liberty Square via Kilby Street from Milk Street. From these vantage points, the base element of the project can be seen to reflect the height and scale of existing structures on the north side of Liberty Square at Kilby and Water Streets. The acquisition of height restrictions on several of these structures will assure that the tower setback from Liberty Square will continue to appear equivalent to its setback from State Street. The use of materials compatible with the nineteenth century red-brick palette of Liberty Square will further reinforce this sympathetic relationship. In addition, the project's massing ensures that no new shadow will fall on Liberty Square.

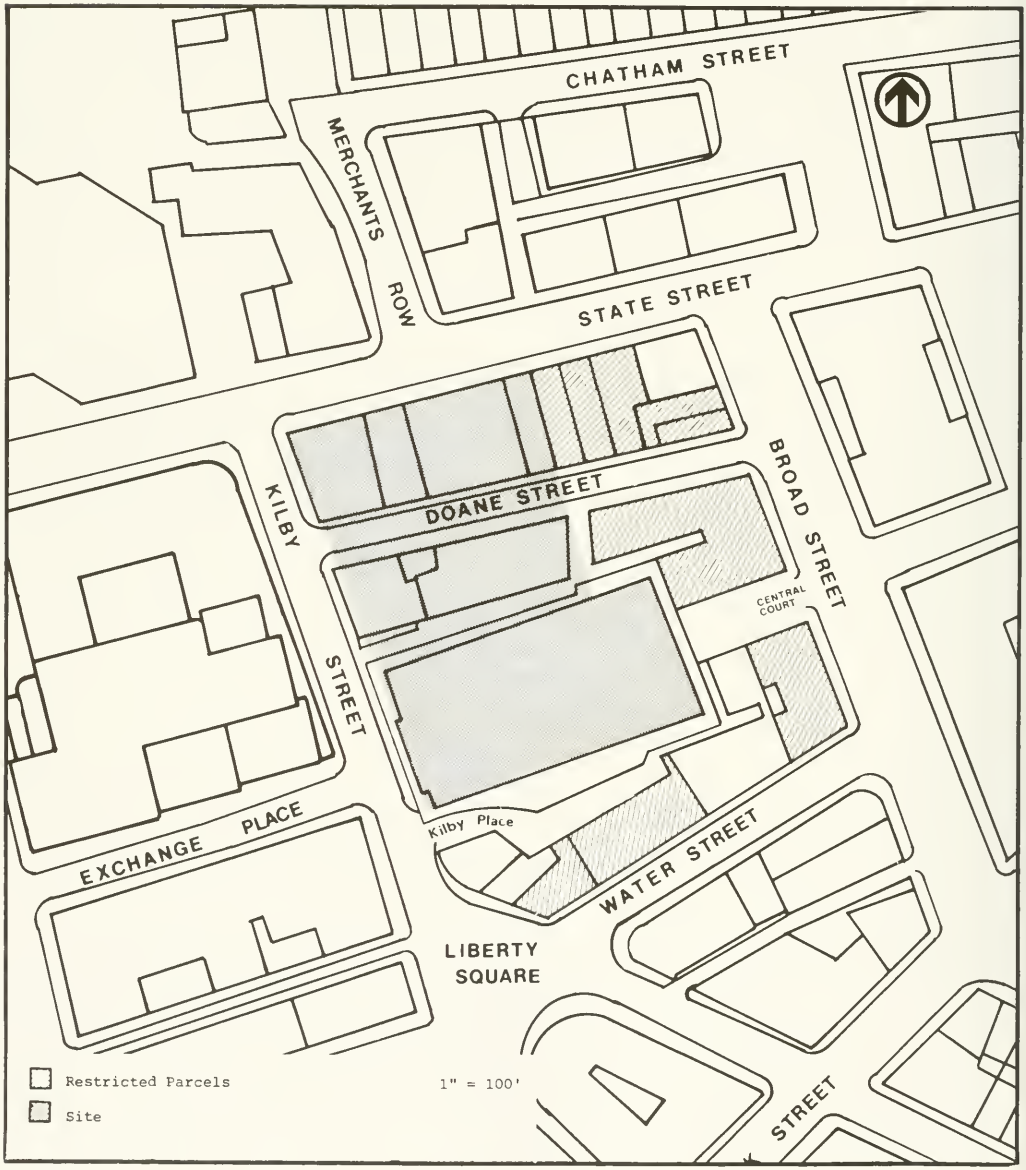
- In assembling the land for the 99 State Street Project, the Proponent has also gained restrictions on additional development on a number of neighboring structures (see Exhibit IV F-9). This will result in the maintenance of the scale and character of the project area.

MITIGATION MEASURES

- Use of low-rise base element and set-back tower configured to minimize shadow and wind impacts and the obstruction of daylight, establishing a consistent cornice line along State Street and creating a new vista of the historic Custom House Tower seen from State and Congress Streets.

Exhibit IV F-9

PROPERTIES FOR WHICH HEIGHT RESTRICTIONS
HAVE BEEN ACQUIRED



- Design of streetscape components to establish coherent State Street frontage.

- Establishment of circulation patterns which reinforce pedestrian movements to and from Merchants Row, and between Broad Street and Kilby Street.

- Improvement of Kilby Street as a public space by removing the existing garage (and related traffic), lowering cornice heights, removing two curb cuts, widening the sidewalk and creating retail frontage.

- Upgrading of Merchants Row using brick, granite and other materials compatible with the Faneuil Hall Marketplace.

- Acquisition of height restrictions on a number of adjacent and abutting properties, precluding significant additional development in the block.

- Choice of materials, scale and rhythm of fenestration to assure compatibility with development in the surrounding area.

RESEARCH APPROACH

This chapter discusses the archaeological potential of the 99 State Street site. The Project Proponent currently controls the site, and has pursued a program of archaeological research and testing in advance of anticipated construction activity. In addition, the Proponent is committed to further archaeological investigation of the site, to be conducted in coordination with the project's demolition and construction processes.

Research conducted to date indicates that the site was actively utilized as early as 1630, and continued to be a prominent commercial district throughout its subsequent development. Fill-depths and cellar depths have been determined in order to help establish locations where resources remain undisturbed. Past activities on-site which have disturbed archaeological deposits include cellar construction, the emplacement of foundation structures, and the location of utilities.

Subsurface testing to-date has included shovel test pits, borings and test trenches which have been located on the basis of historical research. This testing indicates that significant disruption of a large portion of the site has occurred, due primarily to the construction of basements to depths which approach or exceed the depth of fill on-site. No significant archaeological resources have been discovered as a result of these subsurface tests. In areas of the site at which the presense of archaeological resources or of subsurface disturbance has not yet been determined, further testing is planned.

Archaeological investigation of the site has been structured as a four-phase program (described next page). Phase I has been completed and reported on in the Draft EIR. Phase II has been completed since the submission of the Draft EIR, and findings are described in this chapter. Phases III and IV are planned to occur in conjunction with the project's demolition and construction schedule. The methodology for this research program, described in detail in this chapter, can be summarized as follows:

Phase I: Site Reconnaissance (complete)

- Step 1 - Documentary research
- Step 2 - Analysis of cellar depth and fill depth
- Step 3 - Preparation of pre-demolition testing plan

Phase II: Pre-Demolition Testing (complete)

- Step 1 - Shovel test pits
- Step 2 - Test trenching
- Step 3 - Borings
- Step 4 - Analysis

Phase III: Further Pre-Demolition Testing

- Step 1 - Evaluation of Trench Walls
- Step 2 - Borings
- Step 3 - Test Pits

Phase IV: Post-Demolition Investigation

- Step 1 - Utility Relocation
- Step 2 - Pre-Excavation Monitoring
- Step 3 - Archaeological Trenching
- Step 4 - Intensive Survey Report Preparation

HISTORICAL CONTEXT

Site History

The following section presents a brief history of the project site. A detailed history of the project site is presented in Appendix A. Information concerning the site's archaeological resource potential, presented in Exhibit IV G-3, is based on historic maps of the project area, which are included in Appendix A.

Little is known concerning the use of the project site during prehistoric times. However, the most likely areas where prehistoric sites could survive in Boston are places such as the project site, where extensive filling buried original shoreline and estuarine margins. The presense of such a site on the property is, nonetheless, improbable.

Some of the earliest records of the site date from the period from 1630 to 1665, during which the 99 State Street block was in the center of the earliest European settlement in Boston (see Exhibits IV G-1 and IV G-2). Bounded on the north by the main highway leading from the sea to the marketplace, this primary waterfront property was dispensed to some of the most prominent members of the community. The earliest dwellings constructed on the block were either "starter homes" for the owner or used as tenant houses.

At the same time, the waterfront area was wharfed out almost immediately at the end of State Street. The proximity to the waterfront and the location on a major commercial street prompted the conversion of some of the dwellings to taverns which were used not only for entertainment and lodging, but also for government meetings and state dinners. It is probable that the low-water mark was located just east of the present Fiske Building (89 State Street). There is no record of concern about flooding in the town records, and because of the continuous occupation of the site, it is likely that the block was on a bluff.

By the turn of the seventeenth century, the 99 State Street block had become a bustling waterfront area with taverns, warehouses, wharves, houses, gardens and yards for drying clothes. The deeds mention privy and well locations as well. Although many of the landowners did not live on the property, they often housed their children and grandchildren on the lots, passing them on to later generations when they died. For additional income, many landowners added tenant units next to or behind buildings designated for their families. Those employed in the area were primarily merchants, shipwrights, coopers, bakers, shopkeepers, innkeepers, and mariners.

The time period between 1700 and 1760 saw the intense development of the block as a mixed residential, craft

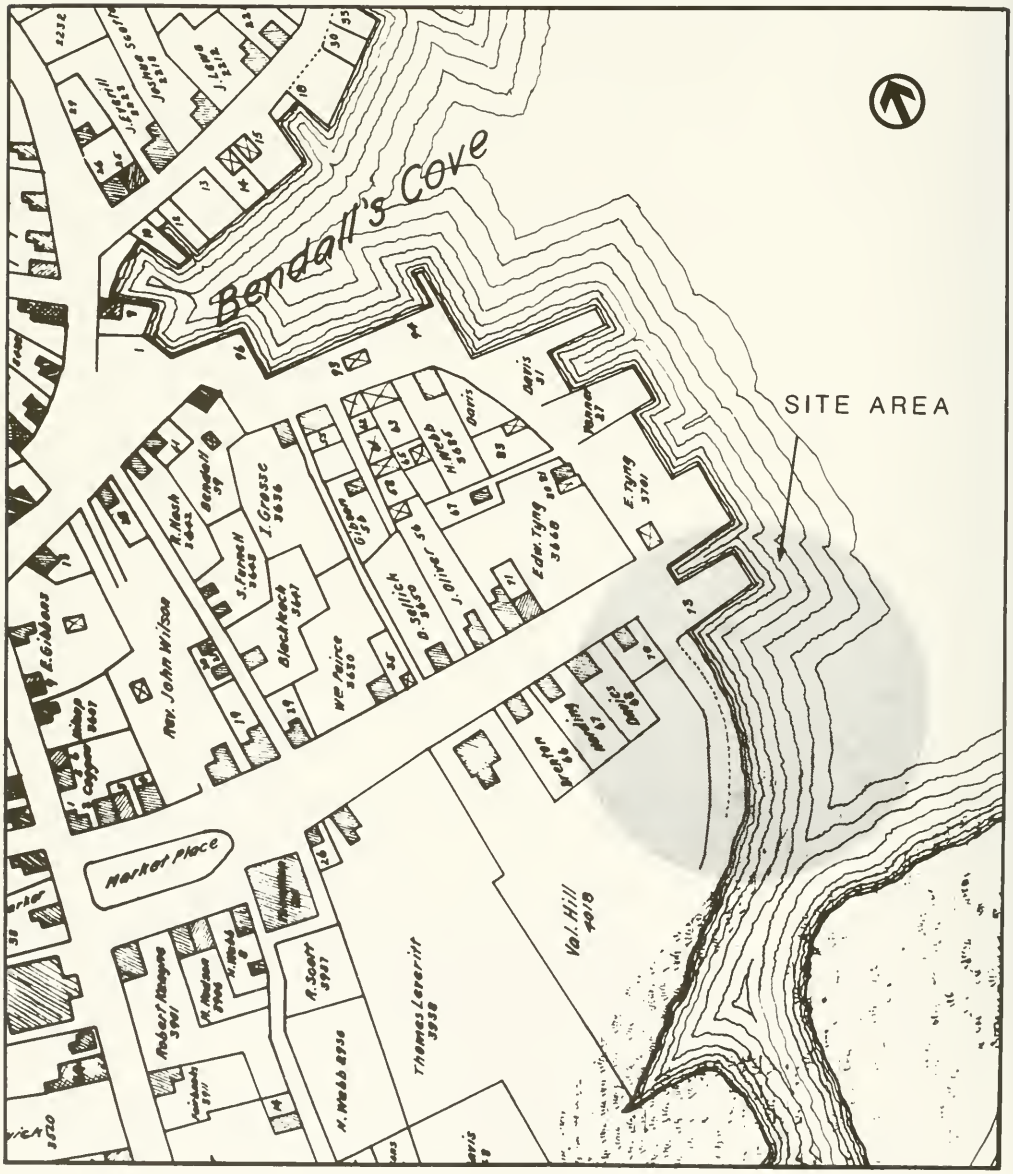
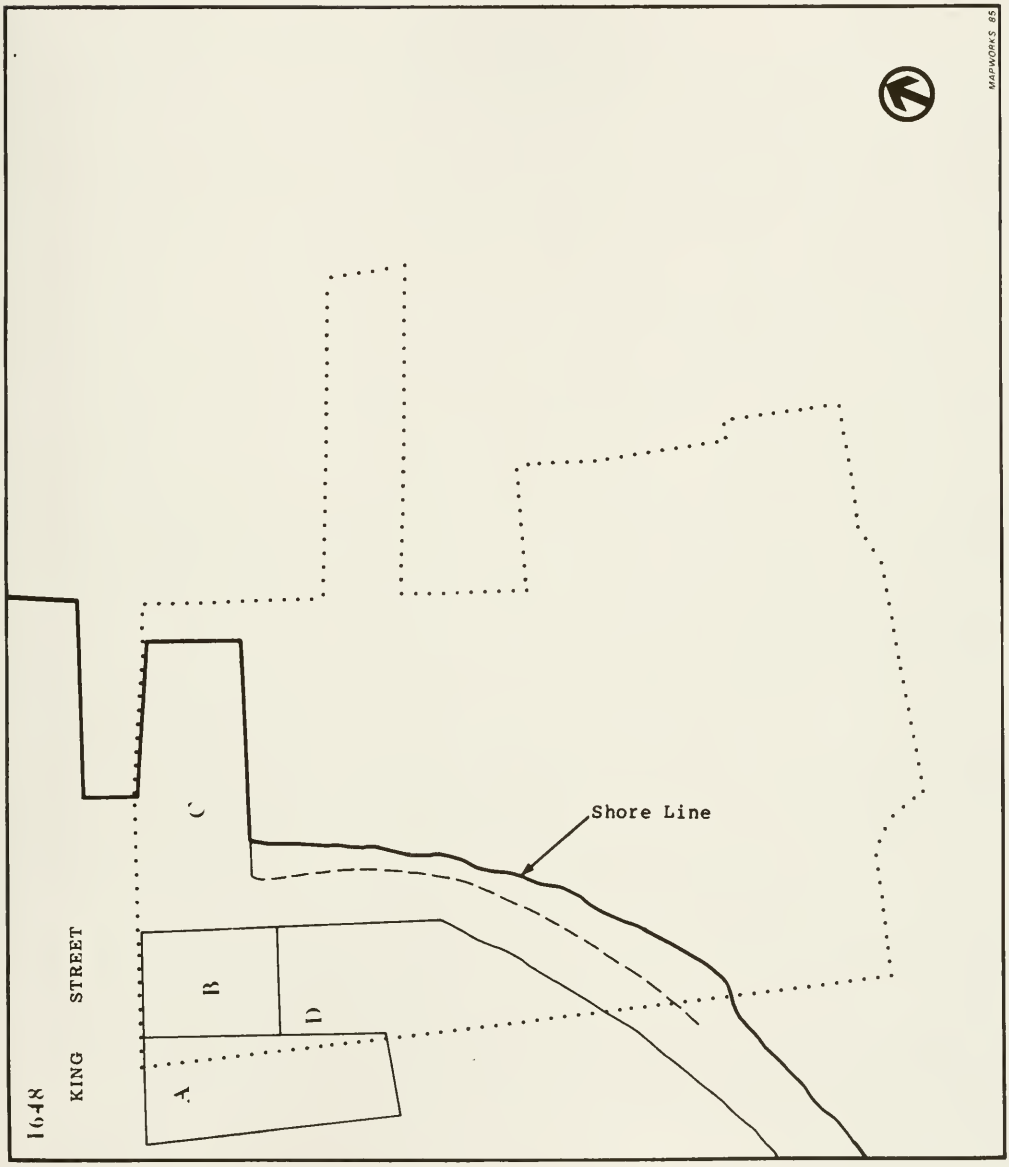

Bendall's Cove
SITE AREA
Market Place
Rev. John Wilson
Vol. Hill
Thomas Leverett

Exhibit IV G-2

RECONSTRUCTION OF 99 STATE STREET SITE
(dotted line) Early 17th Century



and commercial area. Controlled primarily by a few families--the Cookes, the Pecks, the Marshalls, the Borlands and the Doanes--the wharves were enlarged, warehouses built, and additional houses constructed.

The same trends that had been established in the late seventeenth century continued through the first half of the eighteenth century. Craftsmen that settled in the area were primarily coopers and shipwrights. The number of named taverns increased to three: the Bunch of Grapes, the Marlborough Arms, and the Queen's Head.

In 1760, the greatest fire in Boston's history destroyed the entire 99 State Street block. The period after the 1760 fire was one of rebuilding. However, in 1825, another fire swept the 99 State Street block. Fifty stores were consumed in the fire, which was confined to the area bounded by State Street, Kilby Street, and Liberty Square. After the fire of 1825, the 99 State Street area was rebuilt with primarily brick structures. By this time, the landfill activities along the waterfront placed the harbor at least a block away. For purposes of archaeological research, periods after 1825 are not considered significant, except to the degree that activities may have disturbed archaeological resources on-site.

Significance of Expected Resources

As described in the previous text, the 99 State Street block has been part of the hub of Boston's activity since the first European settlement in 1630. Appendix A presents a detailed account of the site's history. Appendix B presents a general framework for the further evaluation of archaeological deposits. The following text presents a summary of the potential significance of archaeological resources which may be found on site.

Prehistoric and Contact Periods

Current models for prehistoric occupation and for the Contact Period do not indicate a high probability for the existence of sites dating from these times within the project area. However, if intact remains from these periods are encountered, they would be extremely significant.

Historic Period

Since it can be expected that some archaeological features or sites dating from this period may be found within the project area, information may be recovered which could be helpful in addressing a variety of historic issues or questions. This section will present block-specific research issues which might, to some degree, be addressed through an investigation of archaeological resources on-site.

The 99 State Street block from the beginning was a mixed-use area. Its location on the waterfront at one of the key landing places in the harbor meant that it was the focal point of many activities. It contained the residences of both rich and poor, single-family homes and inns. Many landowners not only lived on their properties, but had their shops and workshops located on the property. Wharves were built out from the shore into the harbor, and the houses and warehouses were put on them. From the seventeenth to the eighteenth century, the density of the block increased dramatically. A major fire in each century meant that landowners had the opportunity to regroup and rearrange their urban space according to the latest notions, rather than being tied to the existing landscape. In addition, there is no indication that the area was ever depressed or cited for bad conditions. Instead, in the nineteenth century, it became a totally commercial area, catering to the harbor trade.

Intact archaeological deposits within the site would offer an opportunity to examine an area of Boston which was settled in 1630. Information on building construction techniques, lot plans, outbuildings, material culture and foodways of the seventeenth century would be particularly significant because at present so little is known about them. The only early to mid seventeenth-century deposits recovered so far have been in Charlestown. Enough historical information on the inhabitants of the site exists to make possible a comparison within and across social classes, as well as across time periods.

For the eighteenth century, the effect of increased urbanization and of the depression of the 1740s on different crafts and classes represent significant research issues. The fire of 1760 offered a new begin-

KEY

(1) Possible New Data
(2) Possible Corroborative Data
(3) Possible Comparative Data

1 Habitation Prehistoric/Contact (1), Agricultural/Residential 1620-1700 (1), Commercial 1700-Post 1800 (2)

2 Habitation Prehistoric/Contact (1), Agricultural/Residential 1620-1700 (1), Wharf/Residential 1700-1760 (2), Commercial 1760-Post 1800 (3)

3 Habitation Prehistoric/Contact (1), Agricultural/Residential 1620-1700 (1), Wharf 1700-1760 (2), Residential/Commercial 1760-1800 (3), Commercial Post 1800 (3)

4 Habitation Prehistoric/Contact (1), Agricultural/Residential 1620-1660 (1), Wharf 1660-1690 (2), Residential/Commercial 1690-Post 1880 (2)

5 Habitation Prehistoric/Contact (1), Wharf 1620-1760 (1), Residential/Commercial 1760-Post 1800 (3)

6 Wharf 1620-1760 (1), Residential/Commercial 1760-Post 1800 (3)

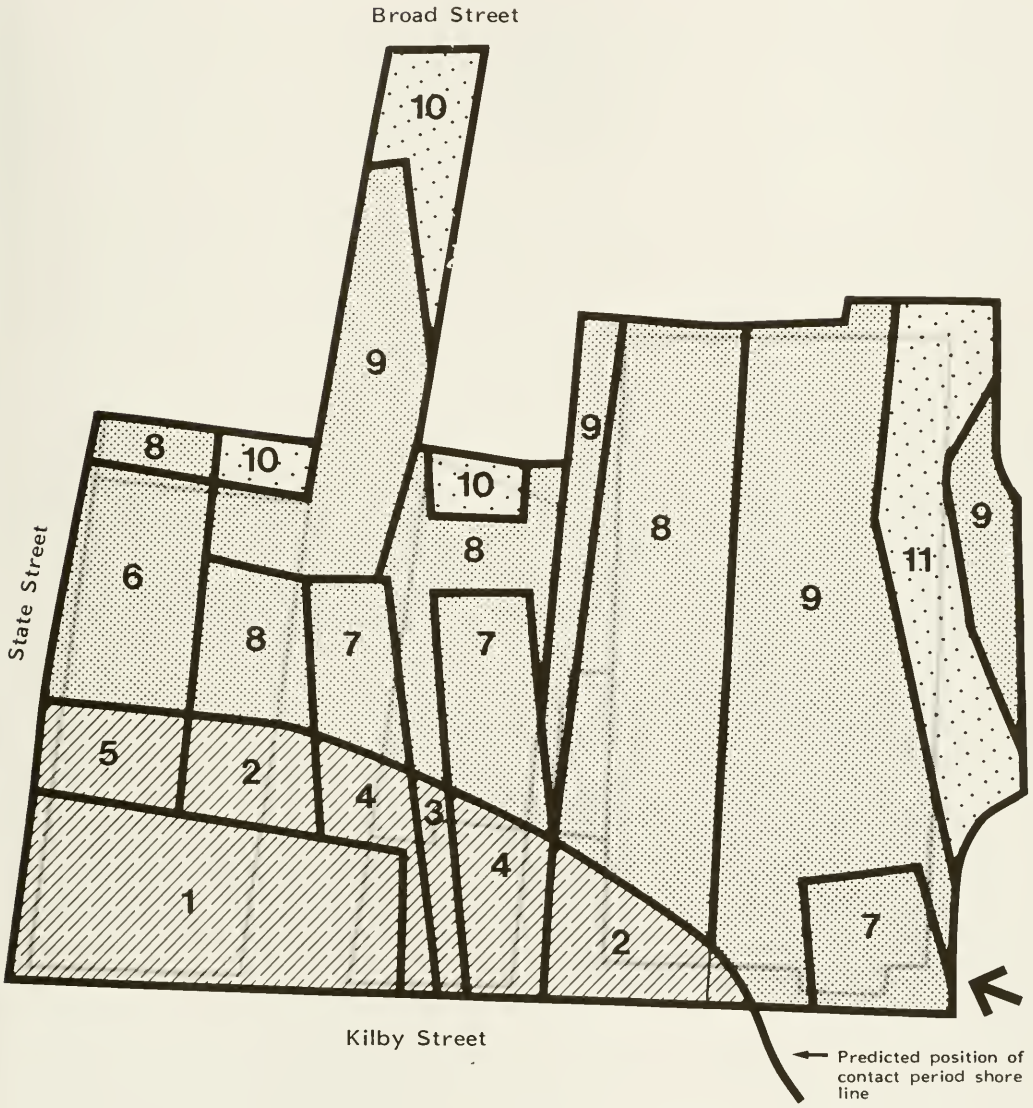
7 Wharf 1660-1690 (2), Residential/Commercial 1690-Post 1800 (2)

8 Wharf 1700-1760 (2), Residential/Commercial 1760-1800 (3), Commercial Post 1800 (3)

9 Wharf 1700-1800 (2), Commercial Post 1800 (3)

10 Wharf, Commercial Post 1800 (3)

11 Commercial Post 1800 (3)


Broad Street
State Street
Kilby Street
Predicted position of contact period shore line
1" = approx. 50'

ning for the inhabitants of the block. It is known that the town selectmen widened Kilby Street as part of the new plan for the area. Key questions include how the post-fire structures and lot plans differ from the pre-1760 era, and whether the change had any effect on the character of the inhabitants and the types of activities that occurred on the site.

It is known that the British occupation and subsequent siege of Boston had a devastating effect on the port economy in the first few years of the American Revolution. While Boston did not suffer the physical damage sustained by communities such as Charlestown and Roxbury, archaeological research may be able to reflect the change in people's attitudes and the effect on their occupations and property.

The post-Revolutionary period was one of new beginnings. Boston's port was thriving again and the opening of the China Trade was important for the waterfront area. The War of 1812 and the embargo had an effect as well. The increasingly commercial aspect of the neighborhood might be detected in the nature of the archaeological deposits. The waterfront by now was more remote and this also may have had an effect on the activities in the area. Post-1825 deposits on this site would not be significant.

RESEARCH TO-DATE: METHODOLOGY

Introduction

The purpose of this study is to acquire information sufficient to allow archaeologists and culturalresource managers to identify the nature and distribution of any archaeological resources that may be impacted by planned development. Establishing the nature and distribution of resources entails the consideration of past site disturbances, which include cellar construction, the emplacement of foundation structures, and the location of utilities such as the 67" sewer line which runs below the Kilby Street Garage.

In contrast to those in rural locations, urban sites such as this present logistical and practical obstacles to the normal flow of research, testing, evaluation, and mitigation. Such conditions are caused by the existence of major standing structures on all or part

of a project area. This situation necessitated the use of predictive modeling coupled with subsurface examinations to identify the nature and distribution of intact significant archaeological resources. This process is described in the following scope of work, which outlines research activities which have been completed to-date.

Phase I: Site Reconnaissance

This phase of work was conducted during the summer of 1985, and was reported on in the Draft EIR, submitted in August 1985.

o Step 1 - Documentary Research

A detailed history of land use at the project location is necessary to identify the types of resources that may still exist within the site. This was accomplished by consulting key primary and secondary documents located at a number of institutions and public agencies in the greater Boston area. Historic period maps were consulted and analyzed to determine the location and nature of buildings at several key points in the site's developmental history. These maps and the results of research at several City agencies made it possible to assess past disturbance that would have destroyed earlier cultural resources. This resulted in documentation that identifies the locations within the site where intact archaeological resources are expected to remain.

Information sources regarding the history of the site were located at a number of local and regional repositories and were investigated by the Project Historian. They include maps, documents, and other materials at the Bostonian Society, State Library, Society for the Preservation of New England Antiquities (SPNEA), Massachusetts Historical Society, and others. As a result of this effort, a detailed history of the site has been prepared, and is presented in Appendix A.

- Step 2 - Analysis of Cellar Depth and Fill Depth

  The goal of this step was to describe the loss of evidence concerning past land use as a result of destructive episodes during the site's history. Documentation of destruction to past land surfaces took the form of building permits (which date specific buildings and imply cellar depth, stabilization methods, etc.), examination of actual cellar depths, examination of the results of archaeologically directed field testing, and monitoring of preconstruction activities. Cores obtained as a part of the development project show depth of existing fill. Cellar depths, when compared to fill depths, reveal remaining undisturbed fill that may contain resources. Coring data were obtained from the project's geotechnical consultant, while permit data were obtained from the City Building Department.

- Step 3 - Pre-Demolition Testing Plan

  On the basis of information provided by Steps 1 and 2, a testing plan was developed utilizing accessible areas on-site. This plan is described in Phase II, which follows.

Phase II: Pre-Demolition Testing

A work plan for this phase of research was presented in the Draft EIR, and has been completed since that time. The work plan presented in the Draft EIR included archaeologically controlled subsurface tests at locations accessible prior to demolition activities at the site. The anticipated activities were two shovel tests, two back-hoe test trenches, and two 2-1/2 inch split-spoon cores. Text below describes the initial testing specifications as well as the actual procedures adapted to site conditions as necessary:

- Step 1 - Shovel Test Pits (Exhibit IV G-4, T.P. 3-4)

  Placement of two shovel test pits in Bang's Alley was recommended.

- Specifications:

  Shovel test units for this project were 1 meter x 1 meter tests. Units did not exceed 5 feet in depth. All cultural material within each unit was accurately documented in accordance with professionally accepted methods. All recovered material was transported to a recognized archaeological laboratory facility for cleaning, analysis, and curation. Analysis of each test unit resulted in the identification of time periods represented and integrity of deposits.

o Step 2 - Test Trenching (Exhibit IV G-4, T.P. 1 & 2)

  Two test trenches were recommended for evaluating the integrity of 73-79 State Street.

- Specifications:

  Test trenches (Exhibit IV G-4, T.P. 1 & 2) were planned to be 10 feet long and the width of a standard back-hoe trench, and to be excavated to below so-called fill layers.

  Trench 1 (Exhibit IV G-4, T.P. 1) was planned to determine the depth of the former cellars of the 73-75 State Street buildings. Prior to the excavation of T.P. 1, a test caisson was placed near the location of the test pit. This caisson placement included the excavation of three large units (one for the caisson and the other two for wells). Archaeologists monitored these excavations and cellar fill was exposed down to clay base. Thus the goals of test pit 1 were met in the course of this monitoring.

  Trench 2 (Exhibit IV G-4, T.P. 2) was planned to discover any intact features associated with occupation of this part of the site. As a result of monitoring the caisson installation, the area was determined to have little or no integrity. However, the back wall of the cellar was exposed in the course of the excavations. A question regarding the integrity of the area behind the wall made it necessary to test behind the wall with a back-hoe trench.

Thus a trench was placed as specified for test pits 1 & 2 and located as shown in Exhibit IV G-4, as test pit 2. This trench indicated no integrity for this part of the site.

o Step 3 - Borings (Exhibit IV G-4)

Two borings placed in the sidewalk along Doane Street were recommended in order to assist in evaluating the depth and integrity of deposits under 89 and 99 State Street.

- Specifications:

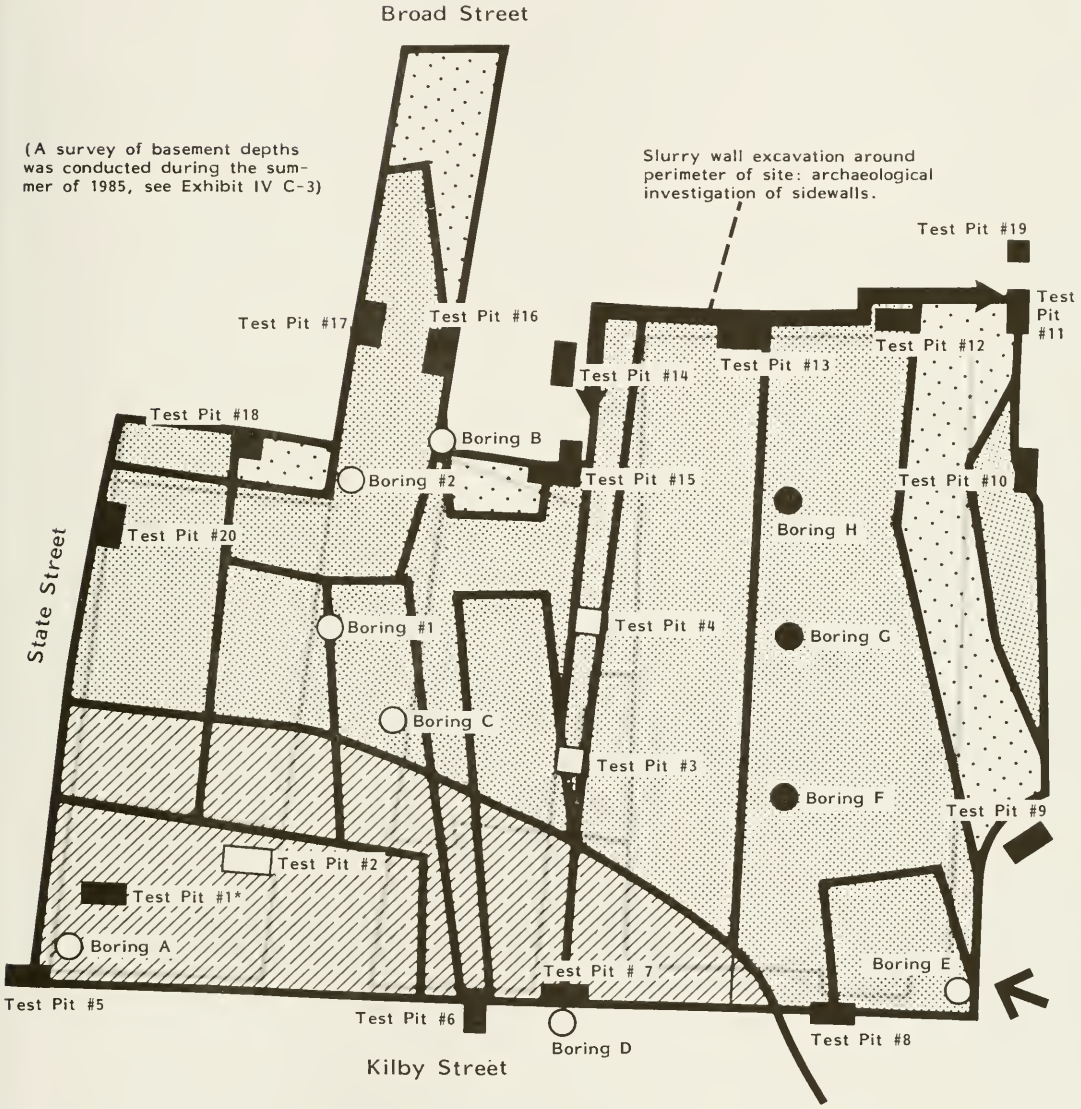
Borings acquired specifically for archaeological analysis were planned to be extracted with a 2-1/2 inch split-spoon coring tool, continuously from ground surface to sterile clay (approximately 10 to 15 feet at this site).

Research subsequent to the DEIR revealed that the locations of the planned borings were the location of under-sidewalk vaults. As a result, the borings were moved to just off the sidewalk. In addition, the borings were accomplished with a 3-inch inside diameter split-spoon tool. (Two-and-a-half-inch split spoons have a 1-1/2 inch inside diameter). This allowed for the acquisition of a larger sample of material, making it easier to determine integrity. Each core was placed in an appropriate container and transported to a proper archaeological lab facility.

o Step 4 - Analysis

In order to assess the potential for intact resources and subsurface disturbance on-site, documentary research and the results of subsurface tests were analyzed by the project archaeologist. This analysis led to findings presented in the following section, and to the preparation of a work plan for additional testing, also presented in this Chapter.

BORING, HAND TEST, AND BACKHOE TEST UNIT LOCATIONS



*Determined not necessary (see text)

Completed Testing

Planned Testing

1" = approx. 50'

RESEARCH TO-DATE:
FINDINGS

Integrity of the Site

The previously described program of work was completed in the Fall of 1985. Findings indicate that significant disruption to large portions of the site has occurred. No significant archaeological resources have been discovered as a result of subsurface testing which has been conducted to-date.

Exhibit IV G-5 shows elevations of State Street, Kilby Street, and Doane Street. The boring information indicated the depth of fill deposits, which, in the present analysis, will be assumed to be the depth of Historic Period deposits. This does not take into account any early features such as post holes, wells, privies and pits which could have been excavated into subsoil. Existing basement depths indicate the depth of disturbance on a site as revealed by physical examination and monitoring of preconstruction tests.

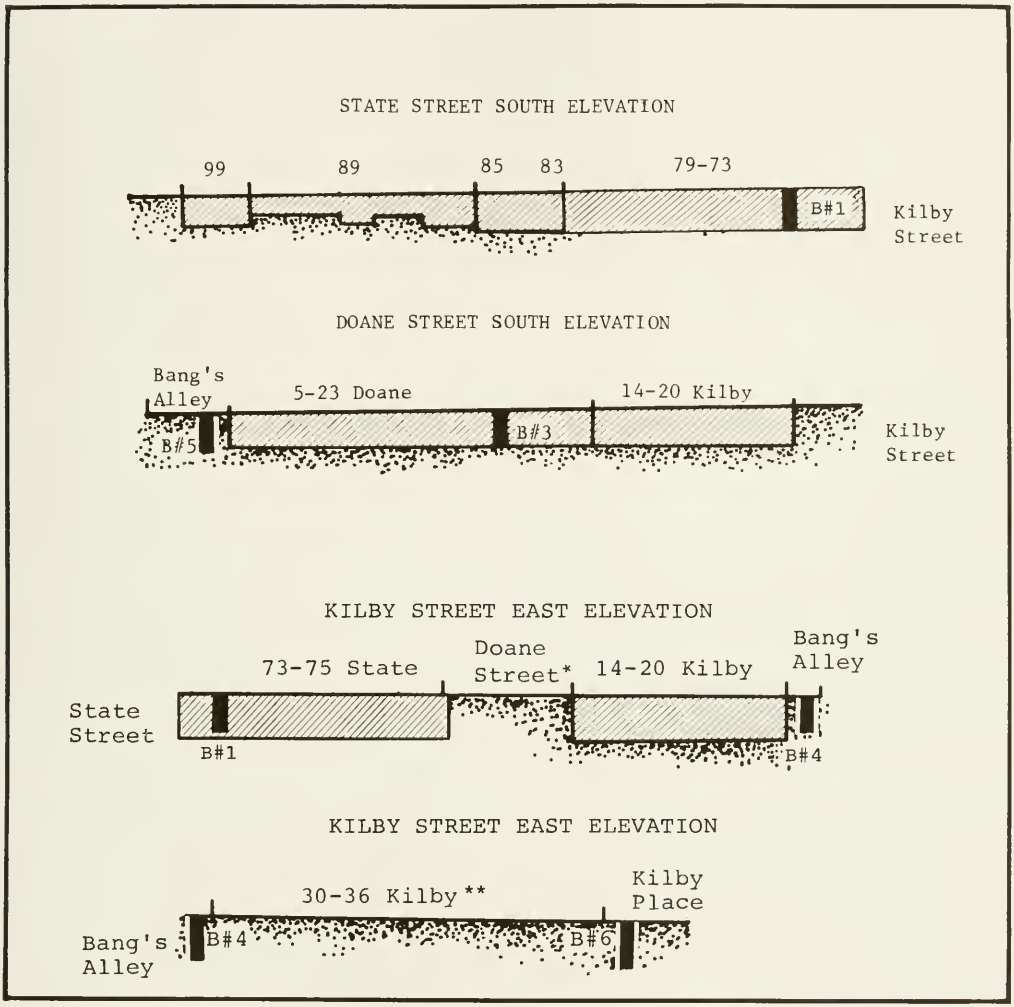
On the basis of previous archaeological work conducted in this area of Boston--at the Bostonian Hotel Site (Bradley 1983), Parcel D-10 (Bower, Dempsey, Mrozowski and Rushing 1984) and the Wilkenson Backlot Site (Beaudry 1984)--we can infer the depths at which archaeological deposits might occur. At the Bostonian Hotel Site, the depth of cultural levels ranged from 8 to 14 feet, the deepest deposits occurring in original waterfront areas that were filled in the late seventeenth and eighteenth centuries (Bradley 1983). At the Wilkenson Backlot Site excavation uncovered an intact seventeenth-century saw pit that extended to a depth of what appears to be 8 feet (Beaudry 1983:29-32). At Parcel D-10, less than two blocks from the 99 State Street block, the remains of Long Wharf and Historic Period cultural debris reached a depth of 13.5 feet (Bower et al. 1984:37). Thus on the basis of previous work it can be projected that archaeological deposits on original land surfaces could reach depths of 8 to 10 feet (if the area has not been cut down), while original waterfront areas which were wharfed out and filled could reach maximum depths of 14 feet.

73-75 and 77-79 State Street

The entire area under these two lots appears to be totally disturbed. This conclusion is based on the following findings.

Exhibit IV G-5

ELEVATIONS
Showing Approximate Cellar Depths as well as Fill Depths Derived from Boring Data



* Utilities present but not shown
** Piles and pole caps present, but not shown

The boring taken in the parking lot at the corner of State and Kilby Streets had fill to a depth of 9.5 feet (Exhibit IV G-5). Sample 2 of this boring, taken from 5 to 7 feet, contained some glass and wood fragments that were too small for diagnosis. Historic photographs of the 75 State Street Building show that it had a sidewalk entrance to the basement, similar to the corner entrance of the Exchange Building across the street. The Exchange Building basement has a maximum depth of 6 feet below street grade at the corner. The 77-79 State Street lot is currently part of the parking lot at the corner of State and Kilby Streets, but also contains a small walk-up Fotomat store. The previous structure was probably a three-story granite-fronted building built before 1888.

Monitoring of several excavations for a test caisson at this location revealed the cellar from the former building to extend to the clay base at approximately 10 feet of depth. The former cellar floor consisted of granite blocks lying directly on the clay beneath the fill layers. The locations of these excavations were within the area where Test Pit 1 was planned to go, and the monitoring of these excavations met the goals of Test Pit 1. From the monitoring of these units it is clear that the basement and foundation of 73-75 State Street fully impacted earlier archaeological deposits. The back wall of the building was identified within the excavations and it was determined that while the proposed Test Pits 1 and 2 were not necessary, it was necessary to view behind the wall since it was possible that the 20 foot area from Doane Street to the wall was intact. The excavation of Test Pit 2 revealed that this area had also been subject to previous cellar disturbance. Thus the entire area under the lot at 73-75 and 77-79 State Street appears to be totally disturbed.

83-85 State Street

The 1924 five-story brick building on this lot has a 10-foot-deep basement that has probably destroyed any early archaeological deposits. Monitoring and testing in the adjacent parking lot confirmed this conclusion.

89 State Street

The area under this lot appears to be, at minimum, partially disturbed. The 15-story Fiske Building has a very shallow basement of approximately 5 feet below street grade. Two areas on the north wall of the building, the boiler room and the sump-pump area, have been excavated to 6 to 8 feet below grade. A false concrete floor exists in at least some areas. The current condition of the basement is hazardous because of two fires, one of which occurred in the basement. An archaeological 3 1/2-inch inside-diameter split spoon boring was taken on the Doane Street side of the Fiske Building to determine the depth of deposits under the building.

The boring revealed the probability of 2 to 5 feet of fill deposit below the various sections of the Fiske Building by recovering fill deposit to 10 feet. Thus intact deposits may exist within this zone.

99 State Street

The area under this lot appears to be, at minimum, partially disturbed. The five-story brick building at 99 State Street has only an 8-foot-deep basement. This basement may date to the previous structure on the site. A boring taken across Doane Street contained fill to 9.5 feet. Sample 3 of this boring, taken from 9.5 to 11.5 feet, contained several remnants of wooden wharf piling and the fill continued to 13.5 feet. This would suggest that 99 State Street sits on filled land and that there may be archaeologically significant remains under the cellar. An additional boring on the 99 State Street side of Doane Street confirmed this prediction with a fill depth of 10.6 feet. While the boring was originally planned for the sidewalk at this location, pre-boring research found that below-sidewalk vaults constructed to the depth of the inside cellar ruled out the location. The boring was placed at the edge of the street instead.

14-20 Kilby Street

The foundation for 14-20 Kilby Street was excavated in 1919. The nine-story structure has a 12-foot basement that reaches under the sidewalks of both Kilby and Doane Streets. This building has probably obliterated any significant archaeological resources.

5 Doane Street

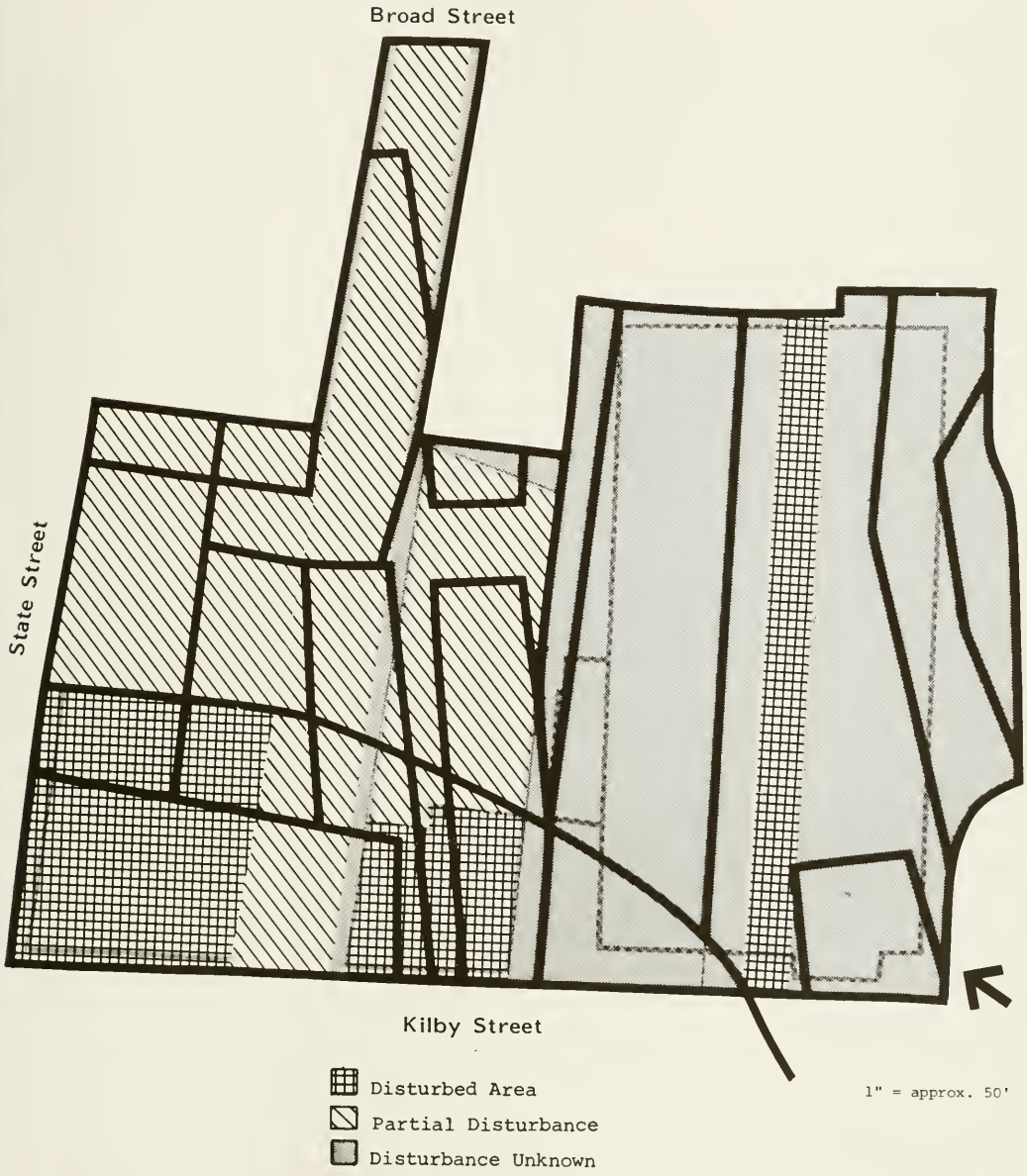
The area under this lot appears to be, at minimum, partially disturbed. The 5 Doane Street Building was constructed in 1922, with a 10 foot basement depth. A boring taken in front of the building found fill to 10 feet below grade. A boring taken at the corner of Doane Street and Bang's Alley near the northeast corner of the building found fill and wharf deposits to 13.5 feet. Two hand-excavated test pits in Bang's Alley behind the building indicated fill to approximately 8 to 9 feet, although no archaeological features were found in these test units. Thus, the 10 foot basement depth appears to have disturbed at least a large proportion of resources at this lot, although it is possible that some resources may remain at points where fill exceeds 10 feet in depth.

Doane Street was originally a 10-foot-wide street leading to Peck's Wharf in the early eighteenth century. It is possible that earlier well and privy deposits exist under the street, as well as remnants of earlier foundations.

30-36 Kilby Street

Disturbance of the area under this lot has not yet been fully determined. The parking garage at 30-36 Kilby Street has no cellar. However, plans from the construction of the parking garage are not available, so there is no information on how pilings or other foundations may have impacted the site. A boring taken at the northwest corner of the garage uncovered fill deposits to 9 feet below grade. A boring taken at the southwest corner of the site had fill deposits to 10.5 feet below grade. Before the parking garage, the lot contained two commercial buildings split by Central Street.

The Central Street portion of the site is the most likely to contain intact deposits because it was probably not built on after 1760. However, the elevator system of the garage may have impacted this area, as may pre-1968 utilities. Review of construction plans of the garage would be the most helpful step in determining the integrity of this lot. Should additional boring or test loads be done in Kilby Place, they will be monitored by an archaeologist. The Proponent


Broad Street
State Street
Kilby Street
Disturbed Area
Partial Disturbance
Disturbance Unknown
1" = approx. 50'

currently plans to take borings through the existing garage floor in order to better determine disturbance under this lot.

The hand testing in Bang's Alley has also shed light on the depth of deposits under the garage. Analysis of the hand tests reveals that any disturbance below approximately 8 feet will have eradicated remaining archaeological deposits.

FURTHER RESEARCH PLANNED

The work plan presented here comprises Phases III and IV of the overall archaeological investigation of the 99 State Street site (see Introduction). The plan is designed to establish the location and nature of any significant resources remaining intact within the project area. These additional phases of work follow extensive documentary research, field testing and monitoring of construction-related testing, which have indicated that substantial portions of the site are disturbed. Further research is required to assess subsurface conditions on remaining portins of the site.

The objective of Phase III is to identify further areas which may contain intact archaeological resources, and--to the maximum degree feasible--to continue pre-construction investigation of the site so that subsequent construction activities can proceed with a maximum degree of certainty regarding subsurface resources and disturbance. This will include the unusual step of taking borings through the concrete floor slab of the Kilby Street Garage in order to assess subsurface conditions at that location. The objective of Phase IV is to complete the archaeological research by conducting post-demolition testing of areas which are currently inaccessible due to the presense of structures on-site.

Phase III: Further Pre-Demolition Testing

- Step 1 - Evaluation of Trench Walls

  Archaeologists will participate in the evaluation of trench walls excavated for the purpose of foundation inspection. This evaluation will include the documentation of stratigraphy and collection of diagnostic materials that will support or modify

the results of this current study effort. All documentation, material recovery, and analysis will conform to the same standards as Trenches 1 and 2. Additional goals of this participation will be the acquisition of additional data in order to evaluate the nature and integrity of deposits in those areas expected to contain resources. Once the inspection program is planned, archaeologists will identify those trenches requiring their participation.

- o Step 2 - Borings

  Borings currently proposed to provide project planners with additional geotechnical data will be monitored by archaeologists. The core sections extracted from the first 20 feet will be examined and the presence/absence of cultural material will be recorded. Plans include borings to be taken through the floor of the existing Kilby Street Garage. These cores will augment the information regarding site integrity and will aid in identifying significant features should they be encountered.

- o Step 3 - Test Pits

  A program of approximately 16 additional test pits (see Exhibit IV G-4) will be conducted to provide planners with geotechnical data, and will be monitored by archaeologists.

Phase IV: Post-Demolition Investigation

- o Step 1 - Utility Relocation

  During the process of utility relocation, archaeologists will participate in the process of uncovering the utilities and examining the exposed sidewalls of the trenches in order to identify features and components of any resources uncovered. All cultural material recovered from the sidewalls will be accurately documented in accordance with professionally accepted methods. All recovered material will be transported to a recognized archaeological laboratory facility for cleaning, analysis, and curation.

- Step 2 - Pre-Excavation Monitoring

  It is currently planned to place caissons and construct a slurry wall around the perimeter of the project area prior to general site excavation. In order to make way for the caissons and the slurry wall, some preliminary excavation will be conducted to remove obstructions such as old foundations. It is probable that this pre-excavation will also remove so-called fill and old basement structures to below basement levels. Archaeologists will investigate the sidewalls of the pre-excavation in order to evaluate the integrity of the deposits and to locate any features associated with cultural resources. Analysis of data from the sidewalls will result in the identification of time periods represented, integrity of deposits, and identification of any features encountered.

- Step 3 - Archaeological Trenching

  To complete the intensive survey for significant archaeological resources within the project area, several test trenches will be placed in the currently-inaccessible areas of the project. It is entirely possible that the results of previous phases of work will eliminate the requirement for this phase. Specifications for these trenches are the same as for the trenches previously described within Phase II. It is unclear how many trenches will be required, and continuous coordination among the archaeologist, the MHC, the City Archaeologist, and the Proponent will be essential.

- Step 4 - Intensive Survey Report Preparation

  Interim reports will be prepared at the end of each phase of the archaeological testing activity. The consulting archaeologist will develop a treatment plan for each intact significant resource discovered. With this treatment plan in hand, the MHC, the City Archaeologist, the developer, and the consulting archaeologist will decide on the appropriate approach and implement the treatment plan as accepted. At the completion of this Work Plan, the consulting archaeologist will prepare a report that documents all field and laboratory analysis and conforms to the requirements of the MHC for reports resulting from Intensive Survey.

MITIGATION MEASURES

The program of investigation concerning the archaeological potential of the 99 State Street site comprises the following measures which are intended to minimize any potential effects to archaeological resources:

- Historical research and documentation (complete).
- Analysis of destruction of past land surfaces (complete).
- Implementation of an extensive field testing plan--including shovel test pits, borings and test trenches--carried out prior to demolition, and based on documentary information concerning site history and disturbance (complete).
- Archaeological monitoring/participation in a variety of construction-related site-testing activities, including geotechnical research, evaluation of existing foundations, and sewer relocation.
- Post demolition trenching in currently inaccessible areas of the site, if warranted on the basis of previous site testing.
- Ongoing contact/coordination with the Massachusetts Historical Commission and Boston City Archaeologist.

INTRODUCTION

The following section describes the anticipated construction process for the 99 State Street Project. This process incorporates a variety of impact mitigation measures designed to minimize construction-related environmental effects to the surrounding area.

The construction planning process for this project is currently underway, and is being conducted in coordination with a variety of pertinent public authorities, including the BRA, the Boston Water and Sewer Commission, the Boston Traffic and Parking Department, and the Massachusetts Bay Transit Authority. In order to provide for continued liason with the public agencies, and to ensure overall coordination of construction activities, a construction management consultant with extensive experience in recent downtown Boston development projects has been retained by the Proponent. The construction manager will act as a single point of contact for communications involving construction procedures and related matters during the project's construction period. This period is currently planned to begin in Spring of 1986 and to last approximately 30 months, as described below.

CONSTRUCTION PROCESS

Demolition

Demolition of structures existing on-site is currently scheduled to occur in the Spring of 1986. Although more costly than the use of explosives, standard mechanical demolition techniques are planned in order to minimize the potential for environmental effects to the surrounding area.

So that any changes in the condition of nearby structures can be monitored during the demolition and construction process, the interiors and exteriors of such buildings will be surveyed prior to demolition start-up. In addition, instrumentation will be placed in the Blue Line MBTA tunnel under State Street in order to monitor any movement associated with project-related demolition or construction.

Also prior to demolition, all asbestos will be removed from structures on-site, and disposed of at an approved facility in compliance with pertinent state regulations. Demolition debris will also be properly disposed of off-site.

To the greatest extent feasible, staging will occur on-site. In order to minimize any effects to area traffic conditions, trucks will utilize the most direct routes to and from the Southeast Expressway. In general, truck access will occur via State Street from the Southeast Expressway or Surface Artery. Truck egress will occur via Milk Street to Broad Street to the Central Artery. Doane Street will be closed during the construction period, and will be utilized for truck egress until excavation begins. Emergency vehicle access will be maintained within streets adjacent to the site. Discussion is in progress with appropriate city agencies, such as the Traffic and Parking Department, Public Works Department, and Fire Department, in order to further refine the traffic maintenance program to be utilized during the construction process. This program is expected to include temporary street closings, temporary parking restrictions, and provision for building service access, pedestrian access and emergency/fire access.

Because the Kilby Street Parking Garage will be demolished during this phase, a substantial generator of area traffic will be eliminated. As a result, the addition of truck traffic during construction is not expected to increase area congestion or to decrease the level of service of area intersections beyond current levels.

Pedestrian passage along State Street will be provided for via a covered walkway. Pedestrian circulation through Kilby Street will be maintained using the sidewalk on the west side of the street. Site wetting will be utilized to reduce demolition-related dust in the vicinity of the project.

Utility Relocation

The utility relocation program associated with this project is currently scheduled to occur in the Spring of 1986. The program is described in detail in Section IV-C. Utility relocation will be accomplished by conventional construction techniques, and will occur within portions of Kilby Street, Water Street, Broad Street and Central Street. The relocation program will utilize primarily off-site staging with minimal storage of materials in the area. Excavated materials will be properly disposed of off-site.

Utility relocation will result in no effects to the MBTA Blue Line tunnel under State Street. Implementation of specific portions of the overall relocation program will be phased so as to minimize traffic disruption. Portions of area streets may require temporary closing to accommodate this program. Traffic passage will be maintained within major streets such as Broad Street or State Street.

Excavation and Foundation Construction

This phase of work is scheduled to occur in the Summer and Fall of 1986. Construction of the basement and foundation will require an excavation extending to the property line adjacent to State and Kilby Streets and set back a few feet opposite the adjacent buildings. Excavation below the Kilby Street sidewalk is also proposed.

The site is currently occupied by existing buildings to be demolished. Therefore, the remnants of basement floors, walls, foundations, as well as abandoned utilities will have to be removed as part of the general excavation. Excavated materials will be properly disposed of off-site.

No impact on MBTA operations are expected as a result of excavation. Previous consideration of excavation below the State Street sidewalk has been abandoned in order to ensure that the adjacent Blue Line tunnel will remain unaffected.

Due to space constraints, an open sloped excavation is not feasible. Instead, a slurry wall system will be utilized around the entire excavation. This soil retention system will be compatible with subsurface conditions and will also provide adequate support for the existing adjacent structures, streets and utilities. The slurry wall method will provide greater stiffness than would systems such as soldier piles or sheet piling, allowing only a small magnitude of ground movement and mitigating any need to underpin adjacent structures.

The excavation will extend below the groundwater level at the site. The slurry wall system will act as a concrete diaphragm around the garage and will provide a cut-off barrier to horizontal water seepage, thus

hydraulically isolating the garage structure and minimizing any potential impact on the area's water table.

Where dewatering procedures are utilized, such water will be filtered or passed through sediment detention tanks before being discharged into the city storm sewer or pumped into a groundwater recharge system, if necessary. It is anticipated that the contractor will be required to obtain a dewatering permit from the BWSC before undertaking such actions. In addition, an instrumentation program will be undertaken during the construction period in order to monitor site area groundwater levels.

Because pile driving is not planned as the predominent foundation support system, one of the primary noise generators in the construction process will be eliminated. In addition, the contractor will utilize construction equipment with mufflers in proper operating condition. Land uses to be affected by construction-related noise are primarily office and commercial, with more sensitive receptors, such as the Devonshire Apartments or the Quincy Market plaza area, a substantial distance from the site and separated from noise-producing activities by large downtown structures. All construction activity will fully comply with Boston's construction site noise restrictions (City of Boston Air Pollution Control Commission, "Regulations for the Control of Noise in the City of Boston").

Air quality effects will consist primarily of dust generated by vehicle movements on unpaved or exposed surfaces. In order to minimize this effect, site wetting will be utilized. Other efforts to minimize dust during construction will include minimization of storage of loose construction spoils on-site; location of aggregate storage piles away from areas having greatest pedestrian activity; minimization of transfers and disturbance of loose materials; and use of covered trucks. It can be anticipated that direct emissions from construction equipment will be insignificant.

Using a technique known as "Up/Down Construction," portions of the site will be excavated after the ground floor slab is in place. Because this results in excavation occurring within an enclosed area, reduced dust and noise effects can be expected. This also results

in reduced truck queuing to haul away excavated material, since such material would have to be removed within a shorter period of time under typical construction practices.

Structural Steel Framing and Exterior Skin

Erection of the steel frame of the project's tower element is scheduled to occur during the Winter of 1986 and the Spring of 1987. In general, a tower crane will be utilized for the majority of this work in order to avoid impacts to street operations which might be associated with a mobile crane.

During the tower construction, the ground floor slab of the low-rise structure will be utilized as a construction staging area. By strengthening the load capacity of this slab specifically for such uses, the Proponent will minimize the need for an alternative staging area. Structural steel will be prefabricated off-site to the greatest degree possible. Storage of structural steel will generally occur off-site and outside of the Boston financial district.

Following completion of the tower element's framing, the steel frame of the low-rise base element will occur. This is scheduled for the Summer and Fall of 1987. Construction of the building's facade and exterior elements is also scheduled to occur during the Summer and Fall of 1987. Work on the tower structure's exterior will occur as the steel framing for the low-rise structure is being assembled.

Staging for steel erection and construction of the building facade will occur primarily off-site or within Kilby Street. The loading dock area for the building to be constructed in Kilby Place will be utilized for staging and delivery as soon as completed.

SUMMARY

Mitigation measures to minimize construction-related impacts will include the following:

Foundation Conditions

- Proper disposal of excavated materials.

- Use of slurry wall foundation to minimize ground movements and to protect adjacent structures.

- Preconstruction survey of physical condition of adjacent structures--including the MBTA Blue line tunnel--and monitoring during construction.

- No disruption of MBTA Blue Line tunnel structure. Coordination with MBTA officials as appropriate.

Groundwater

- Monitoring of groundwater levels during construction.

- Filtering as part of dewatering process, if necessary.

Traffic

- Elimination of on-street parking on State Street, if necessary, to maintain the roadway's carrying capacity.

- Designation of truck routes between site and Southeast Expressway.

- To the greatest degree possible, use of a tower crane rather than a mobile crane, thus avoiding impact to street operations.

- Maintenance of area pedestrian flows during construction, to the degree consistent with public safety requirements.

Noise

- Choice of foundation method which does not require pile driving as predominant support system.

- No use of explosives planned for demolition process.

- Use of equipment with mufflers in proper operating condition.

Air Quality

- Wetting of exposed areas.

- Minimization of storage of loose materials on-site; location of storage away from pedestrian areas.
- Use of "Up/Down Construction" technique, resulting in reduced dust and noise.
- Use of covered trucks.

V Measures to Mitigate Adverse Impacts

INTRODUCTION

Provided here is a summary of measures which either have been used or will be used to minimize any potential adverse effects associated with the 99 State Street Project. A more detailed discussion of these measures is included in each of the impact categories addressed in Chapter IV.

TRANSPORTATION

- Relocation of existing garage entrance/exit from Kilby Street to Doane Street (via Broad Street), resulting in the removal of traffic from the area's most congested intersections.
- Placement of loading and receiving facilities at Kilby Place, away from traffic utilizing surrounding streets.
- No increase in parking beyond current number of spaces on-site.
- Improved garage ticketing operations resulting in shortened queuing periods for vehicles waiting to park on-site.
- Location of the first garage level below grade, resulting in ticketing control points that eliminate the need for on-street queuing upon entry.
- Consideration of a parking price policy to discourage excessive demand for automobile access.
- Recommendation for two-way traffic on Kilby Street between Kilby Place and Liberty Square in order to minimize truck movement from the project's loading area to the Congress Street/State Street intersection.
- Recommendation to reverse the direction of Water Street from Liberty Square to Broad Street, in order to provide a full eastbound corridor from the Beacon Hill area to Broad Street. This would also improve traffic operations in Liberty Square by elimination of one approach to that area.
- Sidewalk widening along State Street and Kilby Street.

- Encouragement of carpooling, ridesharing and use of mass transit.

- Recommendation for a variety of traffic operations improvements to mitigate the effects of expected areawide background development.

WATER AND SEWER SERVICES

- Relocation of on-site sewerage facilities prior to site demolition so as to avoid any temporary disruption of existing sewer services.

- Separation of sewage and stormwater lines in all relocated facilities.

- Establishment of a new storm drainage system to collect storm flow not only from the project site, but from buildings along the system's route on Kilby Street, Water Street, Broad Street and Central Street. This will result in the removal of up to 4 acres from the contributing area to the existing combined sewer system.

- Sizing of the new storm drain system to allow for its continuation by BWSC to ultimately separate storm drainage from the upstream contributing area of up to 22 acres.

- Relocation of sewerage facilities so as to ensure full accessibility by BWSC personnel.

- Avoidance of connection/discharge into existing sewerage constructed integrally with MBTA Blue Line structure.

- Provision in project design for a sewage storage tank system to be constructed, if required, in compliance with BWSC standards.

- Use of grease traps at any restaurant kitchen facilities.

- Use of oil/gasoline traps at discharge point of garage drainage system.

- Further in-depth analysis of existing system of area infrastructure to be provided to BWSC prior to sewer relocation.
- Re-establishment of loop service in the process of relocating water supply systems.
- Ongoing contact/coordination with BWSC.

WIND

- Design approach applied which minimizes wind effects, including the use of low base element and setback tower element.

SHADOW

- Use of a low-rise base element fronting State and Kilby Streets.
- Elimination of the 16-story Fiske Building fronting on State Street.
- Use of a high-rise tower element set well back from State Street.
- Doubling of the tower setback from Kilby Street compared with that which was originally proposed.

HISTORIC RESOURCES

- Use of low-rise base element and set-back tower configured to minimize shadow and wind impacts and the obstruction of daylight, establishing a consistent cornice line along State Street and creating a new vista of the historic Custom House Tower seen from State and Congress Streets.
- Design of streetscape components to establish coherent State Street frontage.
- Establishment of circulation patterns which reinforce pedestrian movements to and from Merchants Row, and between Broad Street and Kilby Street.
- Improvement of Kilby Street as a public space by removing the existing garage (and related traffic), lowering cornice heights, removing two curb cuts, widening the sidewalk and creating retail frontage.

- o Upgrading of Merchants Row using brick and granite.
- o Acquisition of height restrictions on a number of adjacent and abutting properties, precluding significant additional development in the block.
- o Choice of materials, scale and rhythm of fenestration to assure compatibility with development in the surrounding area.

ARCHAEOLOGICAL RESOURCES

- o Implementation of a field testing plan--including shovel test pits, borings and test trenches--carried out prior to demolition, and based on documentary information concerning site history and disturbance (completed).
- o Archaeological monitoring/participation in a variety of construction-related site-testing activities, including geotechnical research, evaluation of existing foundations, and sewer relocation.
- o Post demolition trenching in currently inaccessible areas of the site, if warranted on the basis of previous site testing.
- o Ongoing contact/coordination with the Massachusetts Historical Commission and Boston City Archaeologist.

CONSTRUCTION

Foundation Conditions

- o Proper disposal of excavated materials.
- o Use of slurry wall foundation to minimize ground movement and to protect adjacent structures.
- o Preconstruction survey of physical condition of adjacent structures--including the MBTA Blue Line tunnel--and monitoring during construction.
- o No disruption of MBTA Blue Line tunnel structure. Coordination with MBTA officials as appropriate.

Groundwater

- Monitoring of groundwater levels during construction.
- Filtering as part of dewatering process, if necessary.

Traffic

- Elimination of on-street parking on State Street, if necessary, to maintain the roadway's carrying capacity.
- Designation of truck routes between site and Southeast Expressway.
- To the greatest degree possible, use of a tower crane rather than a mobile crane, thus avoiding impact to street operations.
- Maintenance of area pedestrian flows during construction, to the degree consistent with public safety requirements.

Noise

- Choice of foundation method which does not require pile driving for predominant support.
- No use of explosives planned for demolition process.
- Use of equipment with mufflers in proper operating condition.

Air Quality

- Wetting of exposed areas.
- Minimization of storage of loose materials on-site; location of storage away from pedestrian areas.
- Use of "Up/Down Construction" technique, resulting in reduced dust and noise.
- Use of covered trucks.

VI Appendices

Appendix A	Archaeology - History of Project Site
Appendix B	Archaeology - Framework for Evaluation
Appendix C	Seasonal Wind Data
Appendix D	Previous Wind Studies
Appendix E	Previous Shadow Studies
Appendix F	Air Quality Data

DEVELOPMENT HISTORY OF THE PROJECT SITE

The reconstruction of the 1630-1825 development of the 99 State Street block is based on information obtained from the Annie Thwing files, the Bowditch Volumes of Boston Conveyances (1825-1860), and the Clough map reconstruction of Boston in 1648, 1676 and 1798, all in the collections of the Massachusetts Historical Society.

The 99 State Street block is located on the original shoreline of the Shawmut Peninsula. The first group of Europeans settled the peninsula in 1630, when Winthrop's fleet of settlers dispersed from Charlestown and renamed Shawmut Boston. This early settlement clustered around the Great Cove, nestled under the Trimountain and sheltered by Windmill (now Copp's) Hill to the north and Fort Hill to the south (Exhibits VI A-1 and VI A-2). Although the primary landing spot was in Town Cove, State Street (variously called Broad Street, Townhouse Street and King Street) was the great street leading from the sea. It led from a bluff west towards Cotton (later Pemberton) Hill to the area which was to become the market (now the location of the Old State House). Just to the south of the block was Shelter Cove, a marshy area which cut inland to Shelter Creek. At the head of Shelter Creek was a spring, and it was next to the spring that Governor John Winthrop built his house. Probably half of the project area was under water at the time of this first settlement. The corner of State and Kilby streets was and still is the highest spot on the block, from which the land slopes west to the harbor and south to Liberty Square (then Shelter Cove).

1630-1665

The majority of the original land was between State Street and Bang's Alley. Along State Street were small house lots assigned to William Davis and William Hudson. William Davis had a house and garden lot which stood at the east corner of the 12-foot passage (later Mackeril Lane, then Kilby Street) and State Street (Exhibit VI A-2, lot A). Much of his property is now under Kilby Street. Davis was a gunsmith and occupied the property until his death in 1645. His son, Williams Davis, Jr., moved to Barbados after his father's death and sold the house and land to William Ingram, a cooper. Between 1658 and 1680, Ingram built or allowed to be built a tavern or ordinary which was known as the Bunch of Grapes Tavern. This was one of

1648 MAP OF PROJECT AREA

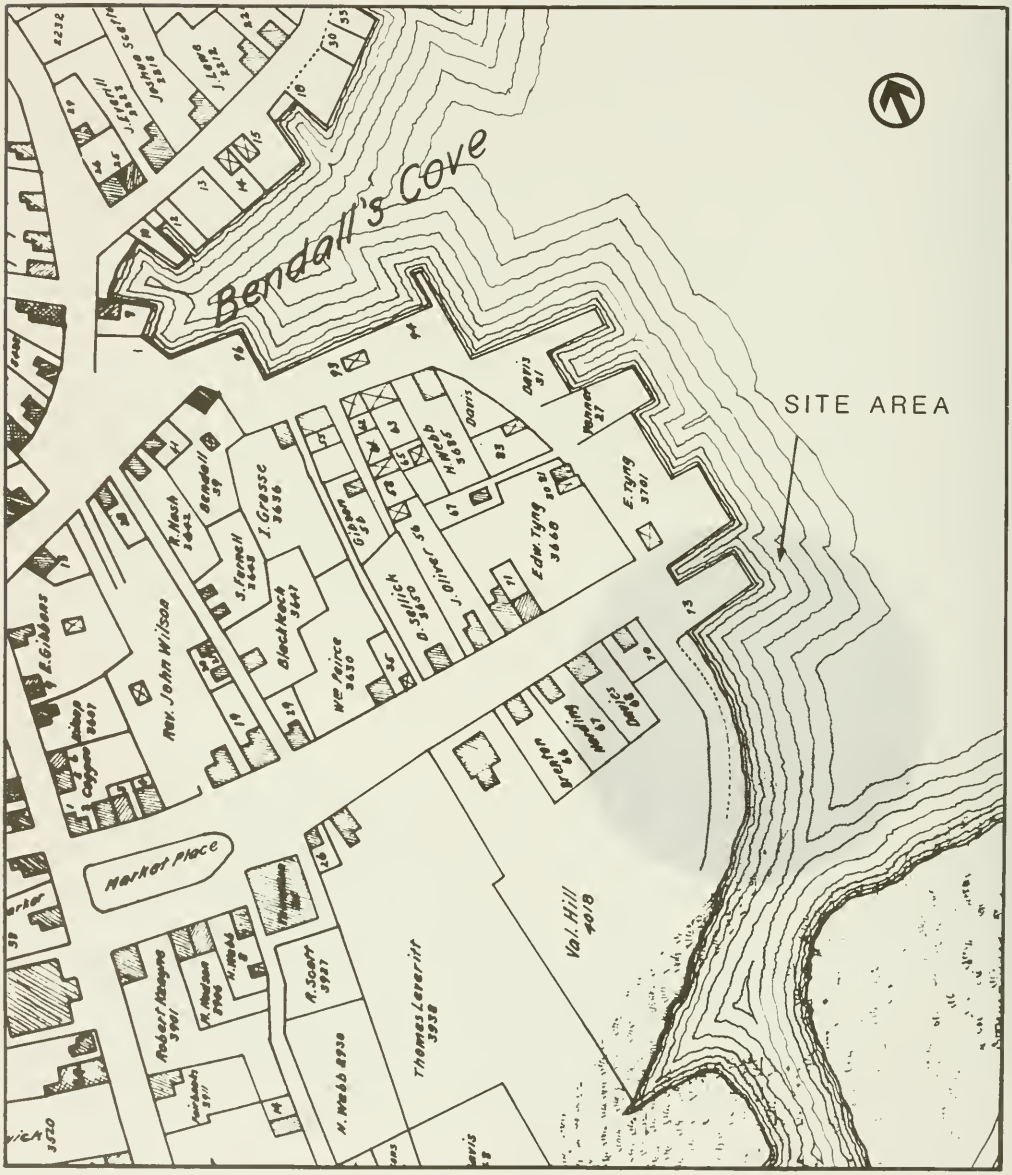
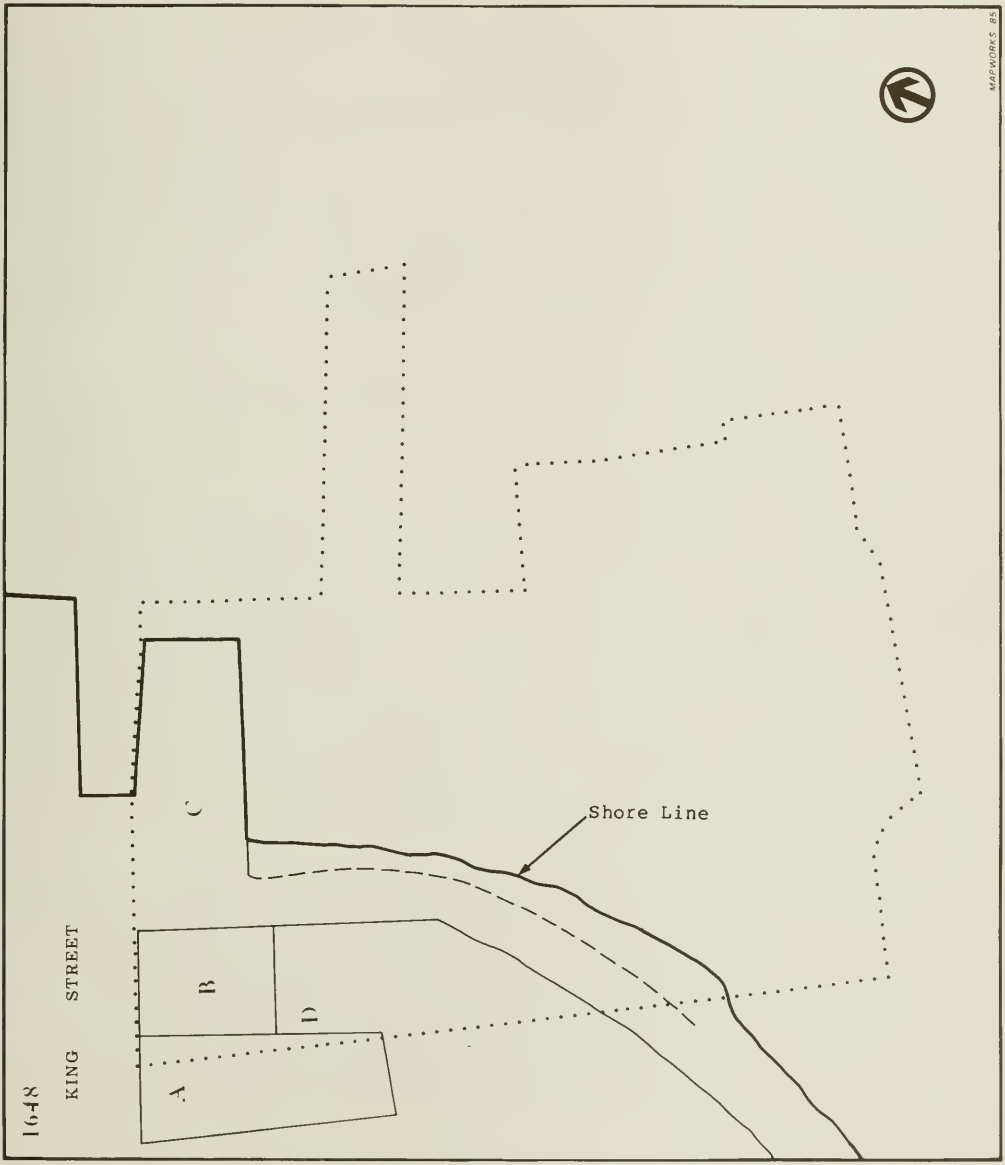


Exhibit VI A-2

RECONSTRUCTION OF 99 STATE STREET SITE
(dotted line) Early 17th Century



Boston's most famous taverns, used for state occasions and selectmen's meetings. Its location near the marketplace, waterfront and church made it a likely meeting place. Historians differ on the exact location of the earliest tavern. Thwing believes it was east of Mackeril Lane with a west extension on the other side of Mackeril Lane (Thwing 1920:137). Whitehill describes it as being at the corner of King Street and Mackeril Lane (Whitehill 1959:26). The City of Boston erected a plaque on the Exchange Building on State Street between Kilby and Congress streets marking its conjectural location. Bowditch places it east of Mackeril Lane and presently under Kilby Street (1825-1860: 17; 200). We can assume that this famous ordinary probably does not survive archaeologically in the present project area.

To the east of the Bunch of Grapes was the house and garden lot of William Hudson, Sr. (Exhibit VI A-2, lot B). Hudson was an early settler, admitted as a freeman in May of 1631 (Rutman 1965: 137, 206). In 1637, Hudson was granted "a foot and a half to come into the street way for setting up of his new building towards the seaside where he dwelleth" (Boston Record Commissioners 2.20). Hudson moved to another residence further from the water by 1647 and allowed his son William Judson, Jr. to first mortgage and then sell his dwelling house. In 1649 the town granded William Hudson, Jr. a license to keep an ordinary (Thwing 1920:137), probably in the seaside building. William Hudson, Jr. then sold the lot to Francis Smith who sold it ten years later to John Holland. Holland promptly died and his widow sold the west third of the land on State Street to Thomas Peck, shipwright. This lot contained "A house now decayed formerly there" (S.D.3.15). The middle third of the lot was sold to James Oliver, who sold it to Thomas Peck.

The final piece of land along State Street is the most difficult to reconstruct. Bowditch's reconstruction in 1825 states that William Hudson sold the final third of his property "to the sea" to John Leverett (Bowditch 1825-1860: 29, 395). Clough's maps and the lack of documentary records suggest that this key parcel may have originally been granted to Elder Thomas Leverett and passed to his son Governor John Leverett at his death in 1650 (Clough 1922). Whatever the circumstances, the waterfront parcel on State Street was

owned by Governor John Leverett by 1660 (Exhibit VI A-2, lot C).

The remainder of the block behind (to the south) of State Street was first granted to Governor John Winthrop, Esquire (Exhibit VI A-2, lot D). Winthrop sold portions of this marshland to William Brenton, Valentine Hill and his son Stephen Winthrop. None of these men lived on the block, preferring to live up the hill, closer to the spring. Brenton arrived in 1633 and employed at least seven servants in the next five years (Rutman 1965:73). It is possible that he constructed houses for his servants on his land near the waterfront. In 1643, Winthrop, Valentine Hill, and others collaborated on a project to dig out Shelter Cove (between the present State and Milk streets around Liberty Square). The selectmen agreed thus on March 29, 1643:

> Having considered the request of sundry bretheren concerning Digging of a creeke for the harbor of boats in the marish near William Hudson Sr., his howse, we doe conceive the worke very necessary, and doe thinke meet to move the Town that (if they shall see good), it may be carryd an end with their common assent: in meanwhile, John Winthrop Esq., Governor, Valentine Hill, merchant, Richard Fayrebanks, Robert Turner and James Davis have liberty to make entrance into the work. (T.R.2.73).

In 1649 there is the first mention of what was to become Kilby Street as "of 12 feet between Capt. Harding and William Davis along straight to the bridge which the town and Mr. Hill set up" (Thwing 1920: 145-146).

Stephen Winthrop's heirs sold their portion of the marsh to John Leverett in 1659. He then sold it to John Hull, James Johns, Peter Oliver and Amos Richardson. Valentine Hill sold his portion to Williams Philpot who constructed a house and a salt house, and to his nephew Richard Hutchinson. Peter Oliver moved quickly to consolidate the southern portion of the block and the entire area around what is now Liberty Square. In 1658, he agreed with Hutchinson to "maintain a small wharf now ruined, lying in a small cove between the wharf of said Oliver and Henry Webb" (S.D.3.130b). In 1664, Oliver bought a warehouse and

the south part of the dock, now known as Oliver's Dock, from John Everard, alias Webb (finishing the consolidation of what was knows as Oliver's Dock until after the Revolution).

To summarize the first developmental period from 1630 to 1665, the 99 State Street block was in the center of the earliest European settlement in Boston. Bounded on the north by the main highway leading from the sea to the marketplace, this primary waterfront property was dispensed to some of the most prominent members of the community. Most were freemen and church members, and many of them held town offices (Rutman 1965: 73-86). The earliest dwellings constructed on the block were either "starter homes" for the owner or used as tenant houses. William Brenton never occupied his lot, but allowed others to construct homes on it. William Davis and William Hudson moved to more prestigious lots away from the wharves, selling out to artisans. At the same time, the waterfront area was wharfed out almost immediately at the end of State Street and at Shelter Cove. The proximity to the waterfront and the location on a major commercial street prompted the conversion of some of the dwellings to taverns which were used not only for entertainment and lodging, but also for government meetings and state dinners. On the basis of the map and deed reconstruction and the boring information, it is probable that the low-water mark, or sea, was located just east of the present Fiske Building (89 State Street). There is no record of concern about flooding in the town records, and because of the continuous occupation of the site, it is likely that the block was on a bluff. From that point, it was wharfed out within the first 20 years of settlement. To the south, the marshland was bridged and dredged to create a sheltered dock in Shelter Cove.

1665-1700

After 1665, the 99 State Street block became more developed. William Brenton moved to Taunton in the late 1660s and divested himself of all of his land in Boston. From north to south, the buyers of his holdings on the 99 State Street block were:

1. Ingram and Thomas Peck (just south of the Davis lot that Ingram bought in 1658) (Exhibit VI A-3, lot D);Thomas Peck (an additional lot seaward east of number 1);

3. John Man (a lot of land and an old house) (Exhibit VI A-4, lot E);

4. John Marshall (a house and a lot of land toward the sea (Exhibit VI A-4, lot F); and

5. John Poole and his wife Elizabeth (Brenton) Poole (land flats and an orchard) (Exhibit VI A-4, lot G).

In 1668, the town granted John Marshall the right to wharf before his house (Boston Record Commissioners 7.41). By 1673, John Man had constructed a warehouse and a wharf and John Poole a wharf with a warehouse and a house on it.

In 1679, a fire swept from the Mill Creek through Dock Square and south to Oliver's Dock, destroying 80 dwelling houses (Brayley 1889:15). John Marshall received 10 pounds for the gunpowder he provided to blow up houses in the path of the fire (Brayley 1889:19). The town quickly rebuilt.

Possibly inspired by the disastrous fire, William Ingram sold his property at the corner of Mackeril Lane and State Street to Capt. John Holbrook, including the tavern called the Bunch of Grapes (Exhibit VI A-4, lot A). Thomas Peck occupied the lot to the east and built houses and a wharf at the end of a lane (Exhibit VI A-4, lot B). Called originally the "highway from Mr. Drummer's Lane (Mackeril Lane) down to Peck's wharf," it later became Doane Street. Next to Peck was the land of Governor John Leverett, containing a house and warehouses (Exhibit VI A-4, lot C). These were administered by his son-in-law Elisha Cooke, Sr. and occupied by Andrew Faneuil (uncle of Peter Faneuil). In 1681, the town reestablished a line between Thomas Peck and Elisha Cooke's houses that had been lost in the fire.

To the extreme south of the block, Peter Oliver's Dock became more fully developed (Exhibit VI A-3).

John Man died in the 1690s and his heirs sold the house, land, wharf and a tavern called "The Queen's Head" on Mackeril Lane to James Barnes, merchant, in 1705. John Marshall died in 1692, and his land was divided between his sons Samuel and Thomas. Thomas Peck died in 1700, having already deeded most of his

1676 MAP OF PROJECT AREA

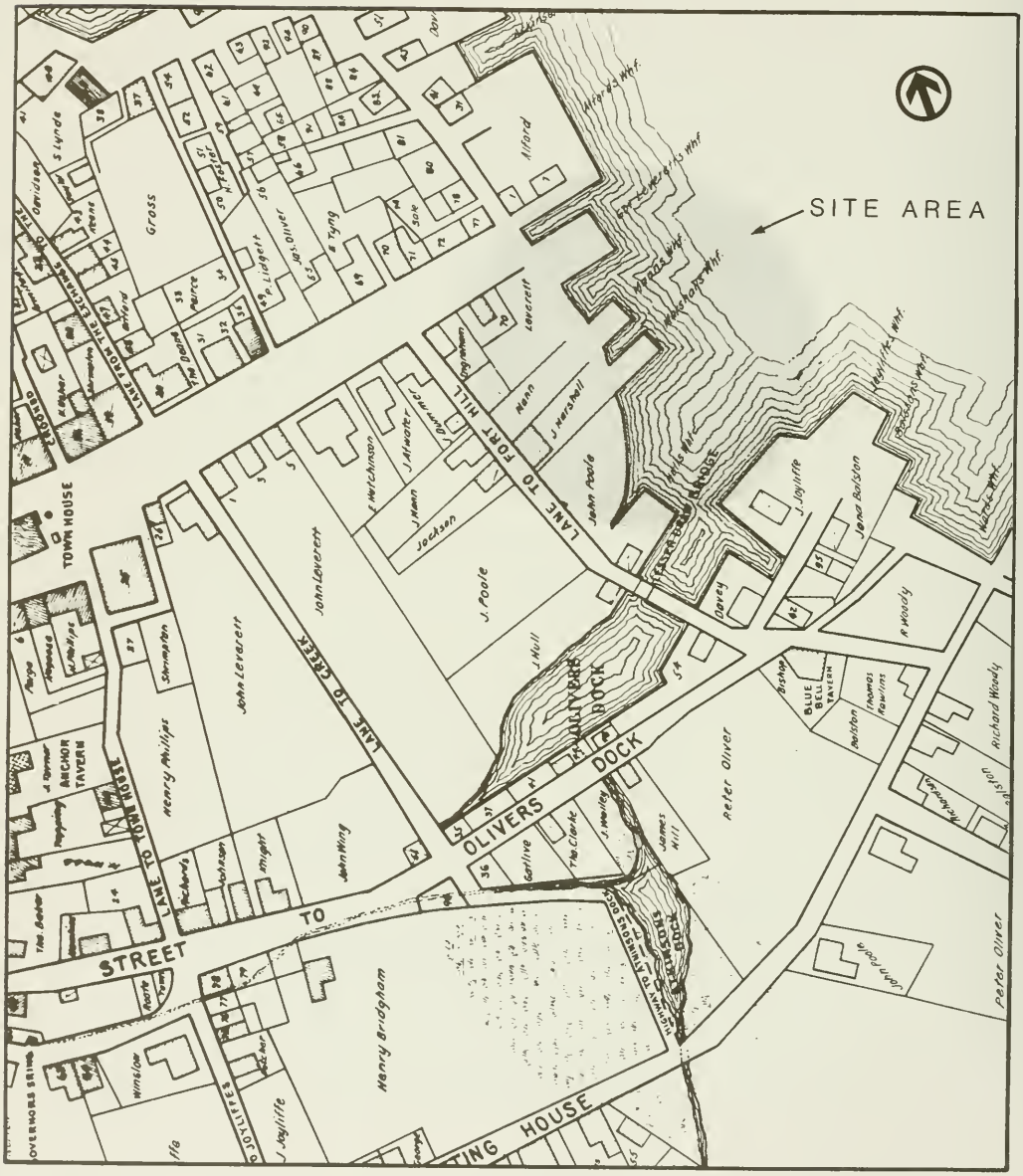
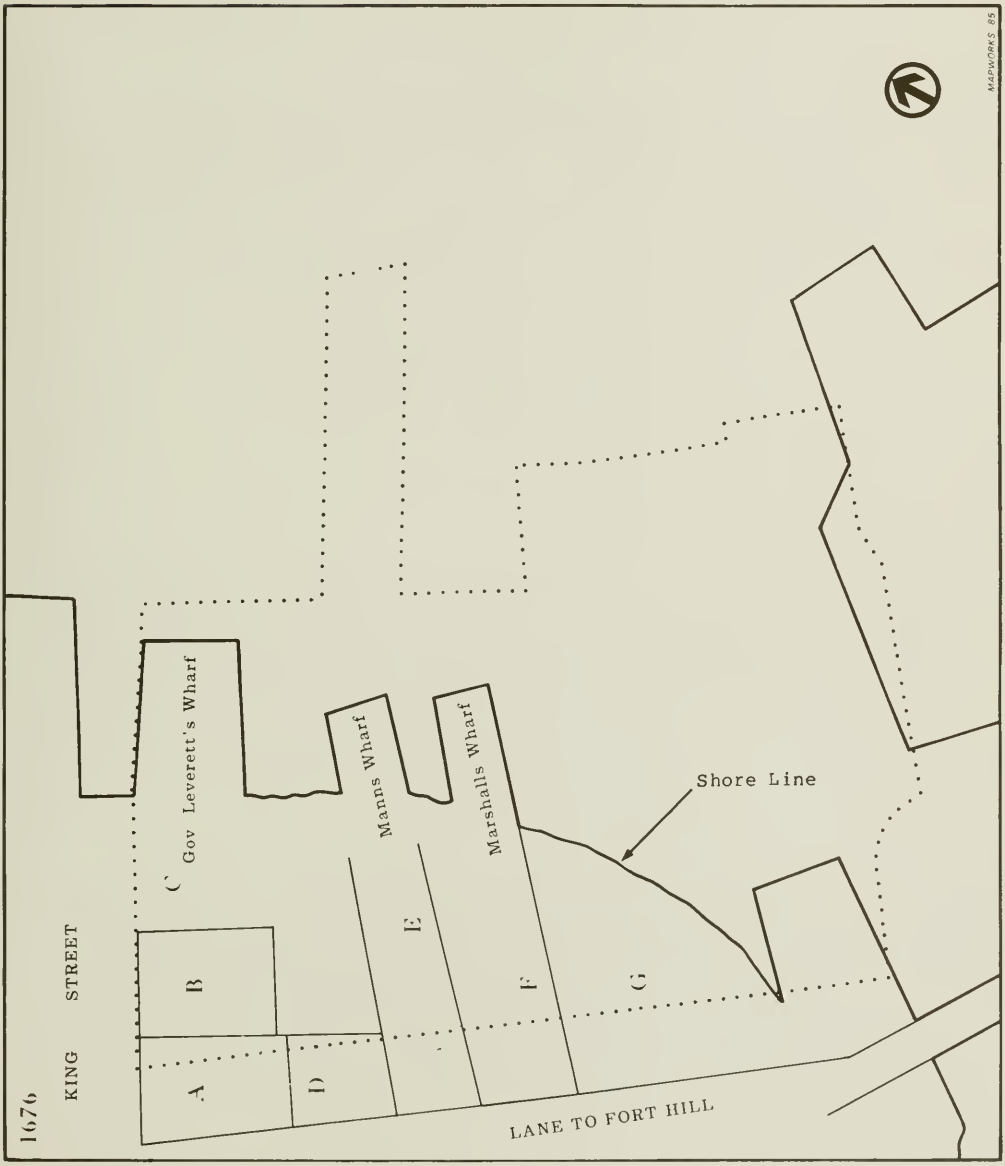


Exhibit VI A-4

RECONSTRUCTION OF 99 STATE STREET SITE
(dotted line) 1676



land to his children and grandchildren, namely James Gooch, mariner; Faith Waldo, widow; and Thomas Peck, Jr., shopkeeper.

By the turn of the seventeenth century, the 99 State Street block had become a bustling waterfront area with taverns, warehouses, wharves, houses, gardens and yards for drying clothes. The deeds mention privy and well locations as well. Most of the buildings, if not all of them, postdated the 1679 fire. Although many of the landowners did not live on the property, they often housed their children and grandchildren on the lots, passing them on to later generations when they died. For additional income, many landowners added tenant units next to or behind buildings designated for their families. Those employed in the area were primarily merchants, shipwrights, coopers, bakers, shopkeepers, innkeepers, and mariners. The wharfing out that had started at the end of State Street blossomed with the construction of Peck's, Man's, Marshall's and Poole's Wharves. These were expanded through the next century until 1880, when the block was completely filled in.

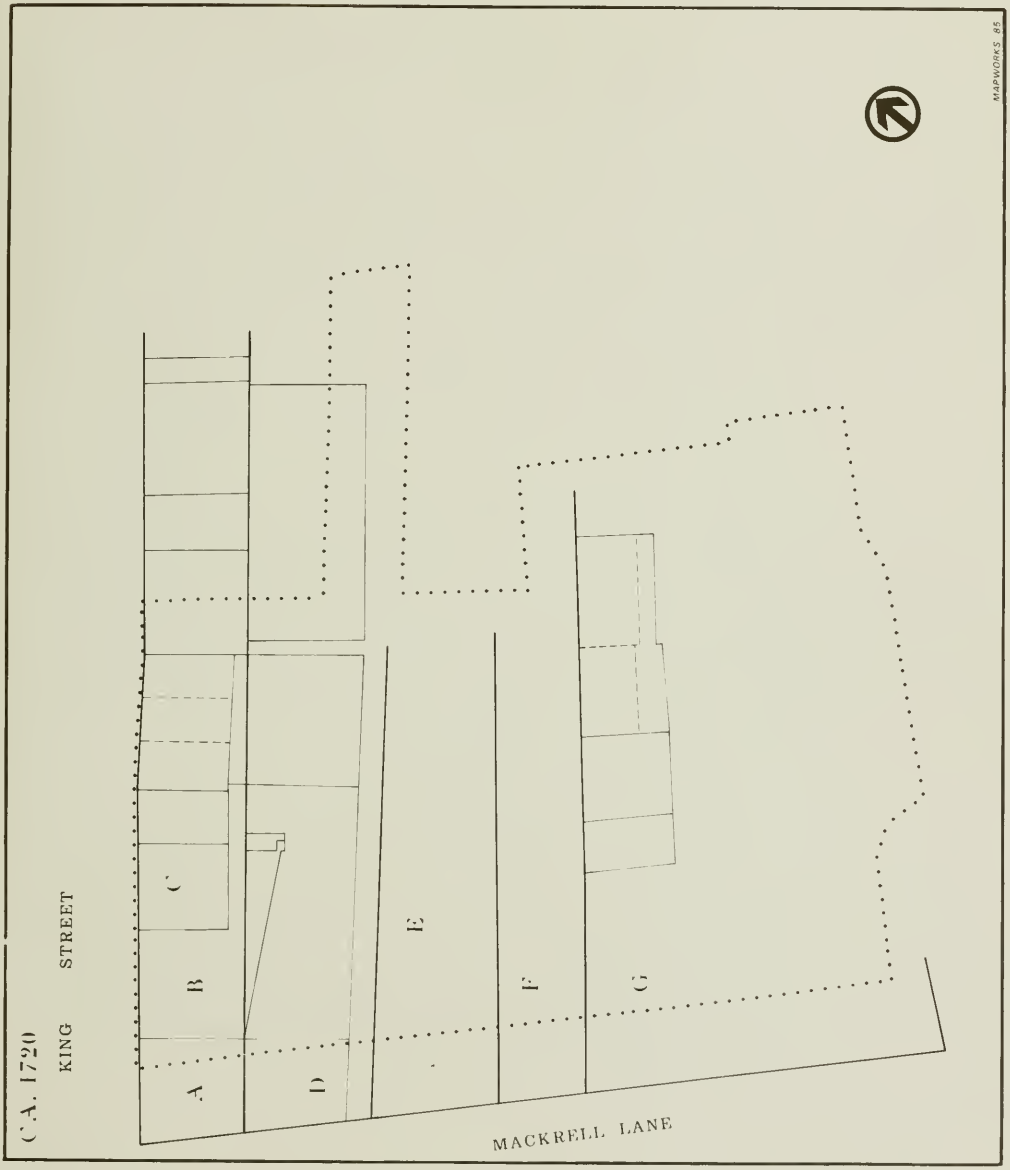
1700-1760

At the beginning of the eighteenth century, the 99 State Street block was a mixed residential, commercial and craft area. In 1711, a great fire ravaged Boston, but was stopped as it reached the project area. A house occupied by innkeeper Francis Holmes was pulled down to stop the spreading fire. Holmes ran the Bunch of Grapes and was succeeded by his wife Rebecca Holmes (Exhibit VI A-5, lot A). The owners of the land, the Holbrook family, kept possession of the tavern and the adjacent land until 1724, then they sold the parcel to Thomas Waite.

Next east was the land of the Peck family, variously occupied by Thomas Peck, Jr. and his nephews James Gooch and William Peck (Exhibit VI A-5, lots B and D). In 1707, James Gooch asked the town's permission to build, east of his house, an addition 28' by 20' by 22' with a flat roof and battlements (Boston Record Commissioners 7.8). When Gooch died in 1732, his land and the land of his aunt, Faith Waldo, were sold to John Doane. Thomas Peck, Jr. sold a portion of his property on State Street to James Givson, mariner, in 1711. Gibson promptly built a new shop, while continuing to

Exhibit VI A-5

RECONSTRUCTION OF 99 STATE STREET SITE
(Dotted Line) 1720



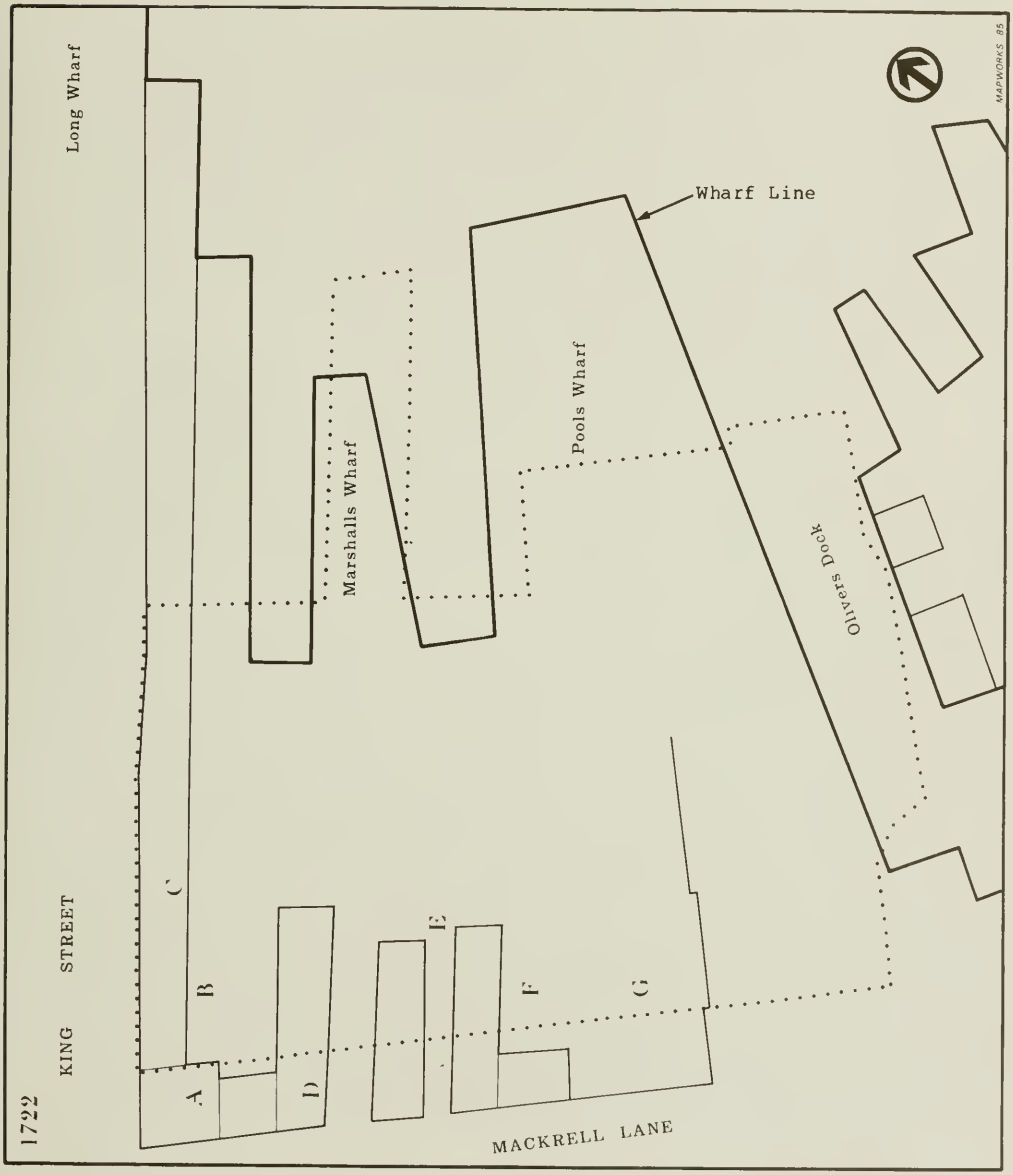
manage the tavern (possibly a successor to the Hudson tavern) called the Marlborough Arms. The Marlborough Arms was sold to Roger Passmore in 1741. The other half of Gibson's property was sold to William Peck, glazier, in 1722.

To the east of these lots was the land owned by Elisha Cooke, Sr., which he had obtained from his father-inlaw John Leverett (Exhibit VI A-5, lot C). Cooke was a doctor, lawyer and statesman. He led the "popular" faction of younger and less established merchants and artisans against the Royal Governor, Joseph Dudley (Nash 1979: 80, 86). His property was described as land and wharf at the bottom of Townhouse [State] Street in Boston, butting on the house occupied by Mr. Andrew Faneuil, merchant with three warehouses, one cooper's shop and flats. He was cited by the town in 1712 for erecting a building that encroached on King Street (Boston Record Commissioners 11.124). These properties were passed on to his son, Elisha Cooke, Jr., on his death in 1715. Elisha Cooke, Jr. also a physician, followed in his father's political footsteps, leading the "caucus" through the 1720s (Nash 1979:87). He received the wharf, the house, the three warehouses, the cooper's shop and flats. His daughter Elizabeth received "the brick tenement in possession of Anne Hubbard, widow" and the brick tenement in tenure of Thomas Warren "with free use of the passageway on east side and to the well therein standing." Elizabeth sold her portion to her brother Elisha (Bowditch 29:395). When Elisha Cooke, Jr. died in 1737, the land was divided among his heirs.

James Barnes, the owner of the Man property, died in 1711. His executors sold his house, land and wharf with flats to the east to John Marshall, cooper, in 1720 (Suffolk Deeds 35.56) (Exhibit VI A-5, lot E; Exhibit VI A-6). Marshall sold the property to John Doane in 1738 (Suffolk Deeds 56.40). When John Doane died in 1755, his property included the former holdings of John Man, James Gooch, and Faith Waldo. His son, John Doane, Jr., received "all house, land, wharf and flats bought of John Marshall" from his father's estate (S.P.R.50.702). When he died soon thereafter, his estate fell to his wife Lucy, who married Atherton Haugh.

Exhibit VI A-6

RECONSTRUCTION OF 99 STATE STREET SITE
(Dotted Line) 1722



The John Marshall estate south of the Man property was divided between John Marshall's heirs, Thomas and Samuel, in 1692 (Exhibit VI A-5, lot F). Thomas Marshall died (probably around 1715) and his son Thomas received the property in 1733. He died in 1746 and the property, including several brick and wooden houses and rights to warehouses and the wharf, was divided among his heirs. Samuel Marshall was a retailer (Boston Record Commissioners 13.314). He deeded portions of his property to Benjamin Salisbury, Elisha Townsend (cooper), and Briant Parrot (his nephew). Parrot bought a cooper's shop and land. When he died in 1756, his parcel, including a double house, wharf and land, was divided between his heirs.

The next parcel south was the Poole estate, containing a wharf and warehouse (Exhibit VI A-5, lot G; Exhibit VI A-6). In 1707, Poole sold his dwelling house, situated on his wharf and measuring 40 by 22 feet, together with the warehouse east of it, to his son-in-law Timothy Lindall. Their daughter inherited the estate and married Francis Borland. Throughout most of the eighteenth century, Poole's wharf was known as Borland's Wharf. Peter Oliver's dock continued to flourish after his death and continued to be known as Oliver's Dock.

In 1760, there occurred the greatest fire in Boston's history. All of Mackeril Lane and the wharves off it were burned, and all the stores in the area "excepting those which front the south side of King Street" (Brayley 1889:60-62). Tenements, warehouses, barber shops, a gunsmith's, several chairmakers', cooper's shops, sail lofts, and a fish market were among those destroyed (Brayley 1889:62). The entire block had to be rebuilt, but first the town selectment decided that Mackeril Lane should be widened 40 feet, taking with it much of the original William Davis lot and the location of the famous Bunch of Grapes tavern. The new street was named Kilby Street in honor of Christopher Kilby, a Bostonian who served as an agent in England, and donated 100 pounds to the relief of the fire's victims.

The time period between 1700 and 1760 saw the intense development of the block as a mixed residential, craft and commercial area. Controlled primarily by a few families--the Cookes, the Pecks, the Marshalls, the Borlands and the Doanes--the wharves were enlarged,

warehouses built, and additional houses constructed. The same trends that had been established in the late seventeenth century continued through the first half of the eighteenth century. Craftsmen that settled in the area were primarily coopers and shipwrights. The number of named taverns increased to three: the Bunch of Grapes at the corner of Mackeril Lane and State Streets, the Marlborough Arms next to it on the east, and the Queen's Head on the east side of Mackeril Lane, probably at the present corner of Doane and Kilby Streets. Leverett's Wharf became a portion of Long Wharf, Peck's Wharf remained as it was, Man's Wharf became first Barnes's, then Marshall's, then Doane's Wharf. The original Marshall's Wharf eventually became Parrot's Wharf, and Poole's Wharf became Borland's Wharf. Oliver's Dock remained Oliver's Dock.

1760-1825

The period after the 1760 fire was one of rebuilding (Exhibits VI A-7 and VI A-8). Francis Borland was "granted liberty to rebuild his warehouse on the wharf to eastward of Mackeril Lane near Oliver's Dock" (Boston Record Commissioners 29.109). Paul Baxter asked leave "to build a cooper's shop on his land at the back of the land where Blue Anchor Tavern was [before the fire] near Oliver's Dock" (Boston Record Commissioners 19.127). Many landowners took the opportunity to divest themselves of waterfront property. The Thomas Marshall heirs sold theirs to Samuel Bang, cordwainer, who built a house shop, and tenements.

The Peck family sold the wharf estate in the rear of the State Street block to Nathaniel Wheatley in 1771 (Bowditch 1825-60:17;200-223). The vacant lots from the corner of Kilby Street and State Street east were rebuilt as brick warehouses. By the 1770s, much of this area was owned by Elisha Doane, Esq., who also gained control of the Wheatley estate in 1780 (Suffolk Deeds 132.105). Wheatley's estate was described as a mansion house, a large red-painted store leading down to the wharf and land and a wharf situated at the back of the mansion house (Bowditch 1825-60:29;394).

Doane's estate was divided in 1783 by his heirs and reassembled by his son Isaiah. The Borland family sold their land, buildings, and wharf to Ebenezer Woodward in 1784, along with the salt wharf near Oliver's Dock.

1798 MAP OF PROJECT AREA

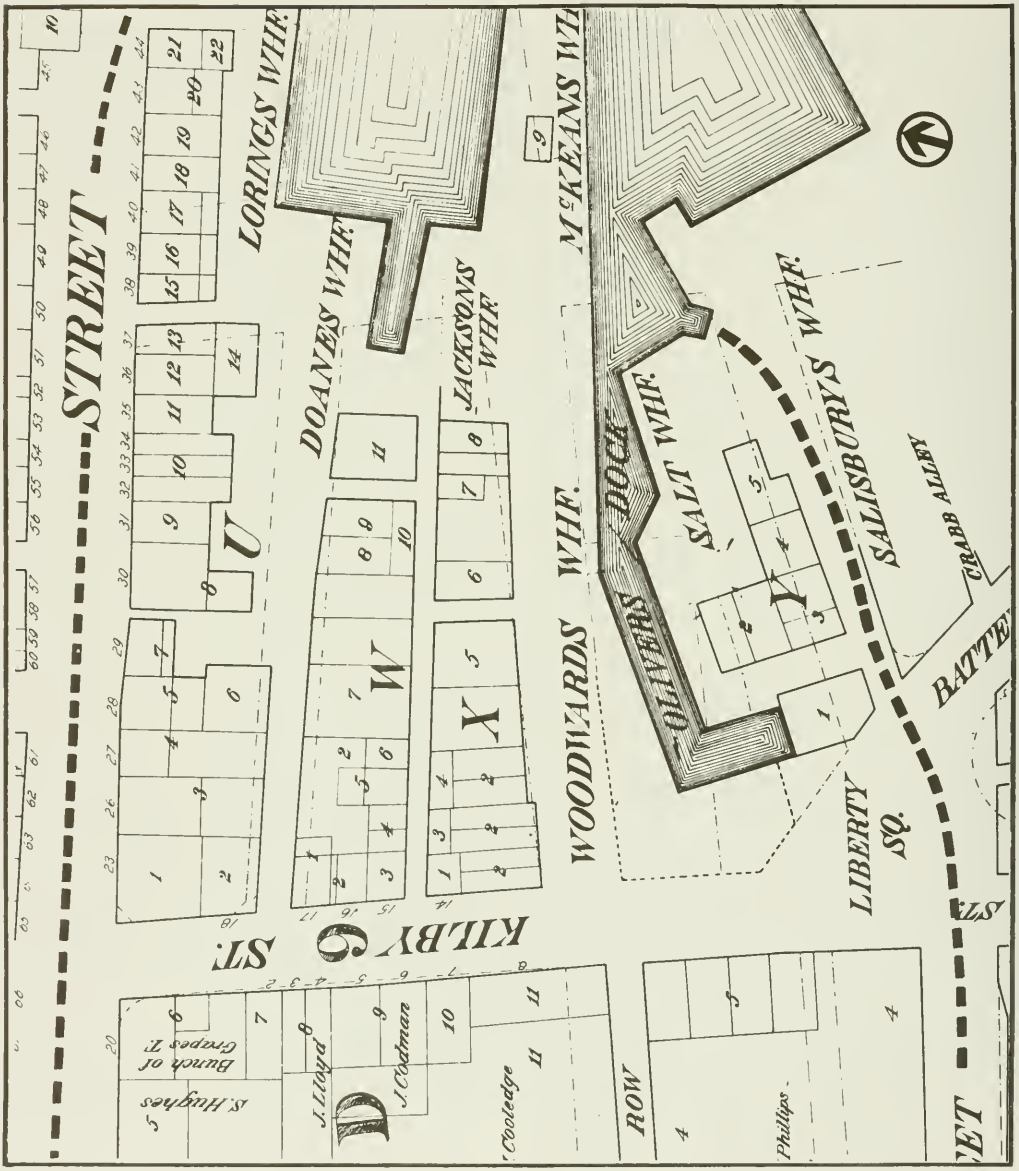
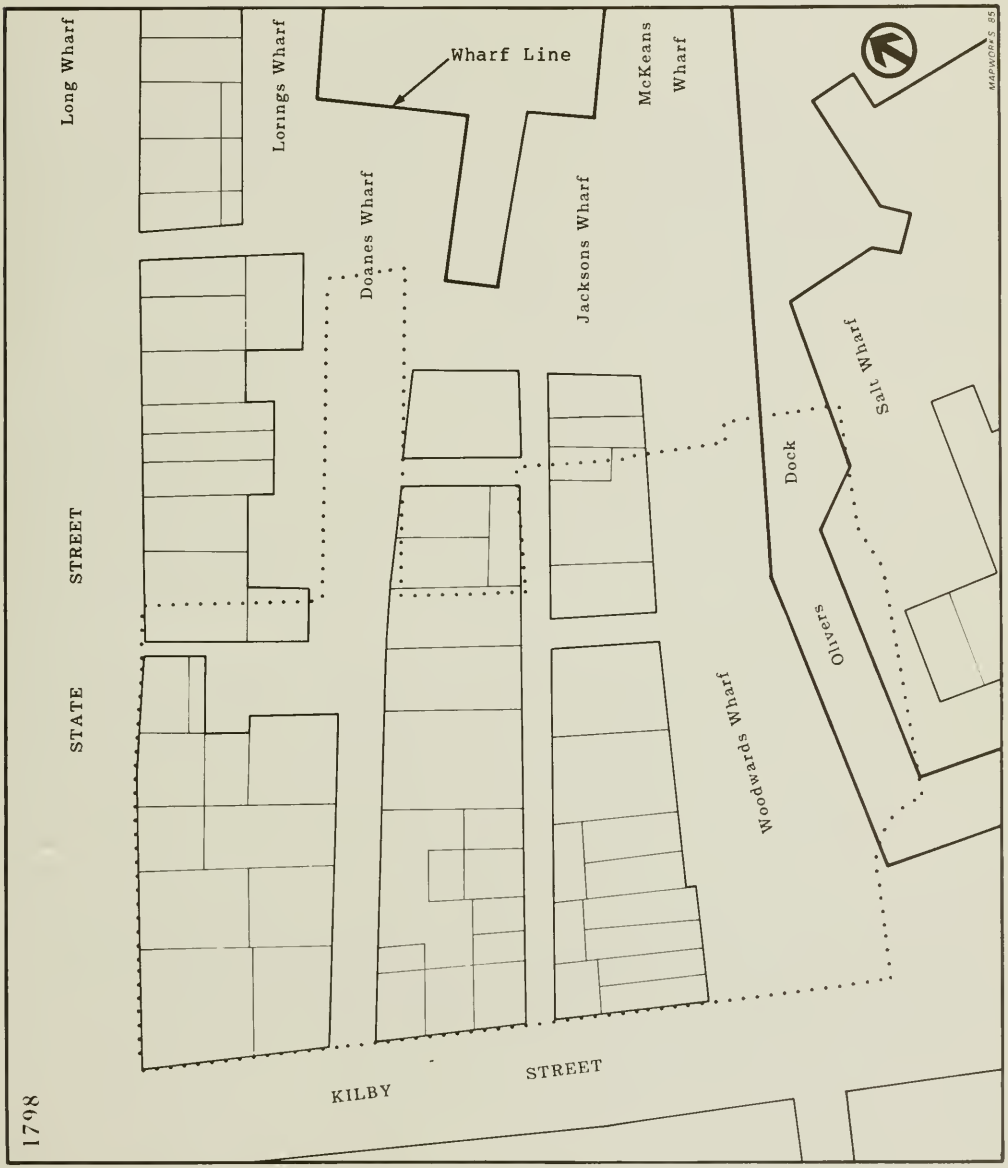


Exhibit VI A-8

RECONSTRUCTION OF 99 STATE STREET SITE
(dotted line) 1798



This parcel was described as "all that wharf and tract in said Boston called 'Borland's wharf' near Oliver's Dock together with the brick warehouse, cooper's shops and shops or row of buildings at the head of same" (Bowditch 1825-60:9;293). On August 24, 1783, a fire occurred at Oliver's Dock in the barn occupied by the wharfinger Mr. Crane. It spread to five other barns, the dwelling house of Jeremiah Russell, and the store of the Hon. William Phillips before being extinguished (Brayley 1889:87). Around 1800, Oliver's Dock was filled in and the Central Street Association was formed to build stores along the road to Woodward's (later Central) Wharf (Larson 1981:2, Bowditch 1825-60:9;301).

In 1825, another fire swept the 99 State Street block. The fire of April 7, 1825 is said to have broken out in a cooper's shop in Doane Street and was caused by cooking clam chowder. The fire spread to old wooden buildings in the rear that were occupied by very poor families. Fifty stores were consumed in the fire, which was confined to the area bounded by State Street, Kilby Street, and Liberty Square. The financial loss was estimated at 1 million dollars (Brayley 1889:148-149). The poor performance of the private engine houses in this fire led to the formation of the Boston Fire Department (Brayley 1889:149).

1825-Present

After the fire of 1825, the 99 State Street area was rebuilt with primarily brick structures. By this time, the landfill activities along the waterfront placed the harbor at least a block away. The threeand four-story brick or frame structures housed commercial businesses associated with port activities; insurance offices, banks, and later telegraph offices. The Lechner's Building on Central Court behind the Kilby Street garage is an example of the type of building that would have been constructed. Most of the present lot lines existed in 1825 and had only two building episodes to the present. Examination of historic photographs, building permits, and the BRA inventory of the financial district suggests these individual site histories.

73-75 State Street, 10 Kilby Street

A ca. 1840 "east view of State Street Boston" (which looks west!) shows the corner of Kilby and State Streets occupied by a brick building with an awning advertising the Fireman's Insurance Office (Society for the Preservation of New England Antiquities-SPNEA-State Street File number 40). A ca. 1850 photograph of an east view of State Street shows a four-story brick commercial building painted white (SPNEA State Street Mounted). Sometime before 1888, the Atlantic National Bank Building was constructed. It was designed by George W. Harvey. The building had a corner entrance of the Exchange Building across the street. The building was destroyed by fire in 1970. It is now a parking lot.

77-79 State Street

Pre-1860 photos show a three-and-a-half-story brick structure. By 1888, a three-story granite-front commercial building had been constructed. This building was also destroyed by fire in 1970. At present, there is a small Fotomat store on the lot.

83-85 State Street

The Fiske Building was constructed in 1889 by J. N. Fiske. It replaced three brick commercial buildings. Although it was originally 10 stories high, the building's roof and top story were damaged by fire in 1961. An additional five stories were then added. The basement of the Fiske Building is only 5 feet below street grade, with the exception of the boiler room in the northwest corner (8 feet below street grade) and a sump-pump area under the entrance (about 6 feet below street grade).

99 State Street

Number 99 State Street is a five-story brick building. The BRA inventory states that this building was constructed in the early twentieth century. The basement is approximately 8 feet below street grade.

14-20 Kilby Street

The 1874 Hopkins Atlas shows two commercial brick structures on the site of 14-20 Kilby Street. The 1919 structure was begun as a nine-story steel-frame building covering both lots. The building was completed in 1922 in conjunction with 5 Doane Street. It has a 12-foot-deep cellar that reaches under the sidewalks of both Kilby and Doane Streets.

5 Doane Street

Number 5 Doane Street is a seven-story brick commercial building constructed in 1922. Prior to 1922, the site was occupied by five brick commercial buildings that were probably constructed in 1825. The elevation from Doane Street to Bang's Alley drops almost 4.5 feet, so the basement level at Doane Street is about 10 feet below street grade, while on the Bang's Alley side it may be only 4 feet. (This portion of the basement was not available for inspection.)

30-36 Kilby Street

The parking garage at 30-36 Kilby Street covers both sides of what was Central Street. From 1825, Central Street was lined with threeand four-story brick commercial buildings similar to the Lechner's Building on Central Court. In 1881, Moses Williams built at 30 Kilby Street a five-story brownstone-fronted office building called the Liberty Building. The building and adjacent structures were demolished in 1950, and the lots served as open parking until 1968, when the present garage was constructed.

Introduction

In order to assign significance to the expected resources within the project area, it is important to establish a framework for evaluation that is based on the current state of knowledge regarding the several periods of Boston's development. Our framework for evaluation derives from two sources. The first is that established by the Massachusetts Historical Commission (MHC) in its historic-preservation planning series. This series of several documents results from the MHC's implementation of the federal Resource Protection Planning Process (RP3), whose product, Cultural Resources in Massachusetts, A Model for Management (MHC, 1979), established the criteria and identified the need for a comprehensive state survey within so-called study units. The "Boston Area" was one such study unit (Exhibit VI B-1).

The establishment of the State Survey Team and the implementation of these recommendations has resulted in detailed studies with accompanying research priorities for a number of the Commonwealth's Study Units, including "the Boston Area."

While the detail of study necessary for any specific development project is not available in these public documents, the evaluative frameworks used for decision making are consistent with the currently-accepted State Historic Preservation Plan and reflect the priorities of the various historic-preservation communities and their constituencies.

Those who specialize in the history of land in Boston have refined these frameworks for Boston proper, a task most recently accomplished by Beth Bower, this project's consulting historian. Thus the framework for evaluating the expected resources within this project's zone of impact is the integration of the MHC's framework as described in Historic and Archaeological Resources of the Boston Area (MHC 1982) with Bower's post-1630 framework for Boston proper.

Integrated Framework

MHC Framework (Prehistoric Period-1620)

Prehistoric Period, ca. 12,000-400 B.P. The previously mentioned "Model for Management" (MHC 1979) describes the physical environment within which the earliest inhabitants lived for close to 12,000 years prior to European Contact.

> The Boston area is defined naturally by a lowland depression of the Boston Basin. This was flooded in post-glacial times by rising sea levels, forming at the same time the tidal estuaries of the Charles, Mystic, and Neponset Rivers. The area is surrounded by a series of granite uplands, such as the Blue Hills, but modern definition is formed by the circumferential Route 128. Historically, the Boston area has served as the primary core of Massachusetts, and at least since the Archaic period (ca. 9,000-2,000 B.P.) has been a center for cultural innovation and development. Throughout prehistory and history transportation corridors have radiated out from settlements in the Boston Basin linking the coast to the interior.

In its report to the Bureau of Land Management entitled Summary and Analysis of Cultural Resource Information on the Outer Continental Shelf from the Bay of Fundy to Cape Hatteras (1979), the Institute for Conservation Archaeology of Harvard University predicted the nature and distribution of prehistoric sites on the Shelf, including the Boston area. These predictions assigned to the Boston area the "Southern New England Estuarine Sequence (truncated)." This sequence predicts the potential for fishing-camp sites dating from the Paleo-Indian Period (ca. 12,000-9,000); fishing camps and shell midden throughout the Archaic Period (ca. 9,000-3,000 B.P.); and shell midden, fishing camps, and habitation sites representing the Woodland Period (ca. 3,000-400 B.P.).

As the MHC has stated, "Given its complex topography and wide range of available resources, it is not surprising that the Boston study unit has a rich and diverse archaeological heritage. (MHC 1982)"

Exhibit VI B-1

BOSTON AREA STUDY UNIT
Adapted from Historic and Archaeological
Resources of the Boston Area
MHC 1982

It is also pointed out that:

> No Paleo-Indian artifacts from the Boston area have been found in any collections. Their absence may be the result of the destruction of likely camp sites, either by rising sea levels or by historic development, rather than the lack of Paleo-Indian presence in the Boston area. Early Archaic remains are scarce although present as occasional finds in multi-component sites. The Middle Archaic is well represented in the Boston area; and approximately thirty sites have been identified.
>
> The most numerous prehistoric remains are the Late Archaic small-stemmed point associations. Late Archaic sites are present in a diversity of ecological zones. Rich burial features have been found in Watertown.
>
> During the Woodland period, sites exhibit a shift towards intensive occupation of the coastal zone with a major reliance on shellfish exploitation. This shift may coincide with the adoption of horticulture as a subsistence strategy. Eleven sites of the Early Woodland period have been recognized in the Boston area. Nearly twenty sites with Middle Woodland associations have been recorded. Late Woodland remains are even more frequent, suggesting an increase in population size. Estuarine heads were likely areas for the location of large villages, but most of these sites were destroyed in the nineteenth century. The size of the Late Woodland population seems generally equivalent to the Late Archaic population, but Late Woodland remains have been found only in the coastal zone. (MHC 1979)

While no prehistoric sites have been scientifically excavated in Boston proper, recent excavations in Watertown (Barfield 1978) and Charlestown (Pendery 1982) illustrate the accuracy of predictions at least for the Middle/Late Archaic and Woodland Periods. Works by Luedtke (1975, 1980) clearly show that the Boston Harbor Islands have been subject to intensive utilization by prehistoric peoples, adding further support to models for prehistoric use of Boston proper.

However, as the MHC points out:

> The classes of prehistoric archaeological sites which survive in the Boston area are generally special-purpose sites located in peripheral areas. Shell middens on islands, lithic quarries, rock shelters, and small camps have often survived, especially in upland reservation and park areas. Sites in core areas that were located in prime lowland, riverside, or estuarine areas (i.e. Boston proper) have largely been destroyed. Though they were partially documented in the beginning of the century, only fragments of these important sites are assumed to survive.
>
> Continuous development in the Boston Area has destroyed hundreds of prehistoric sites, however, some prehistoric sites and fragments of sites have survived, even in the downtown itself. The discovery and salvage of the Boylston Street Fishweir justified caution regarding the possibility of site survival, even in the most developed sections of the city. Similarly, a shell midden is reputed to have been uncovered during excavations for the parking garage next to Quincy Market. The most likely areas where prehistoric sites could survive in Boston and Cambridge are places where extensive filling buried original shoreline and estuarine margins.

This final description accurately identifies the 99 State Street site.

Contact Period (1500-1620). The environment greeting the first visitors provided a number of distinct economic advantages, and thus the area became a focus of early exploration and settlement.

> The area lies at the mouth of the Charles River, a stream which was navigable for several miles inland for the ocean-going vessels of the seventeenth century. The river provided easy access into the interior from which the settlers expected to draw a trade that would yield an immediate profit. In addition, in 1616-1617 a plague had decimated native groups who originally occupied the area. There were few natives left to dispute the ownership of the first European settlers (MHC 1979).

The period has been further described by the Boston Area planning document.

> The major event of the period was European contact with the native population. Though slowly at first, European influence affected and altered native culture throughout the period. Of the many affects, the epidemics of the late 16th and early 17th-century were particularly drastic, decimating the native population and effectively wiping out the social structures of the native groups within the unit.
>
> During the Contact period, the estuaries of the major rivers appear to have functioned as regional core areas. These estuaries (from the coast up to the first major fall line) served as one pole in a seasonal pattern of movement organized around the collection of food and other resources. The other pole, located at the opposite end of the riverine corridor which connected them, was a series of upland tributaries and ponds.
>
> While the details of this pattern of seasonal activity remain unclear, the estuary areas appear to have functioned as regional cores in several ways. They were gathering points for an otherwise dispersed population. Occupied primarily during the spring and fall, they were the focus for community food gathering activities. Fishing was probably the most important activity although the collection of shellfish and hunting of migratory water fowl occurred as well. Finally, although economic efficiency may have brought people together in these estuary locations, these large gatherings were undoubtedly important for social and political reasons as well.
>
> Within the Boston unit, the Neponset and Mystic estuaries were the important regional cores.
>
> Though scattered evidence suggests an active native presence along the Charles estuary, the Charles River appears to have served more as a boundary between the Mystic and Neponset cores than as a separate core area. Further research is needed to clarify whether this was the case or whether the Charles estuary also functioned as a core area (MHC 1982).

The location and study of a Contact Period site on the Shawmut peninsula would provide important new data that would probably modify current thinking as described above.

European activity within the area created changes among both the local populations and the settlers themselves.

> The presence of Europeans along the coast probably intensified the Woodland pattern of coastally-oriented settlement, especially as trading patterns formalized. It did not, apparently, alter the basic pattern of settlement and seasonal movement. During the final decades of the period, newly introduced infectious diseases devastated the native population. Although considerable cultural disorganization resulted, the survivors continued to cluster in the two traditional core areas.

The primary transportation system during the Contact Period was a complex network of trails. Generally these followed the natural contours of the landscape, changed elevation at an easy grade, and favored sunny rather than shady slopes whenever possible. Besides avoiding rough or difficult terrain, the trail network had a braided character, branching around obstacles and offering a variety of alternative routes for crossing the landscape.

The second group of trails were those which ran along the estuaries and out the peninsulas which extended into the bay. These provided access to the tidal flats and the other resource of the bay and islands. Trails of this kind were located on Winnisimmet (Chelsea), Mishawam (Charlestown), Shawmut (Boston), Mattapanock (South Boston), and Squantum (Quincy) as well as Winthrop and Cambridge [emphasis added].

While the trail network appears to have been the major transportation system used by native people, archaeological evidence from the Harbor Islands and ethnographic accounts indicate that water transport was also used.

No period settlements have been archaeologically documented within the study unit. A few pertinent settlement descriptions do survive from ethno-historical sources. (MHC 1982)

Bower's Refined Framework

Early Settlement (1620-1660). When John Winthrop's fleet sailed south from Salem in 1630, Charlestown was selected as the compromise settlement location in the Boston Basin. The peninsula's restricted water supply and company politics resulted in the dispersing of the original group to other locations, including the Shawmut Peninsula, renamed Boston. Boston became the seat of the Massachusetts Bay Colony government and was the primary port in the region. Although some agricultural pursuits were followed, Boston's unique topography made it better suited to commercial and craft activities. In this first period, temporary homes were built, lots assigned, fields laid out, shops opened, wharves built and eventually permanent structures constructed. The early nucleus of the settlement was along the Town Cove.

To date, few archaeological remains of early settlements have been found in the Boston area, Massachusetts, or southern New England. Sites have been excavated in Maine, New York City and in the Virginia Tidewater area. Discovery of intact "first period" remains would be significant in determining how the peninsula was first settled, the type of structures which were erected, how the immigrants adapted to their new environment and how the first settlers interacted with the larger colonial economy. These findings would provide a basis for analysis of future research results in other early Boston-area settlements. They could be compared with documentary and archaeological research in Charlestown and Plymouth Colony and with the results of archaeological research in Maine, New York City and the tidewater area.

Seventeenth-Century Town (1660-1690). Boston grew rapidly in population and settlement density throughout the seventeenth century. By the end of the century, the social structure had become stratified, with prosperous merchants (10% of property holders) owning 40% of the wealth (Nash 1979:20). Boston was an entrepot for goods coming in from the countryside, Europe and the Caribbean, and a major Colonial craft center. By the turn of the century, Boston's working class and artisan communities were lobbying for more participation in the government.

Although more remains from this time period have been uncovered during archaeological monitoring and excavation in the Boston area (Bostonian Hotel site, Wilkinson Block) and the southern New England (Wellfleet Tavern), we still know little about the material life of port-dwelling seventeenth-century New Englanders. Deetz's analysis of several Plymoth sites suggested that seventeenth-century life was more communal and egalitarian. Certainly the availability and quantity of high-status items were limited during this time period. Historical research, archaeological excavation, and analysis of remains dating from 1650 to 1690 would enable us to define the availability and distribution of various material items, building types, outbuildings, and foodstuffs to different groups in seventeenth-century Charlestown. This analysis would provide a basis for analysis of future research results in other seventeenth-century Boston-area settlements, as well as comparative data for Deetz's Plymouth Study.

Entrepot (1690-1789). Boston was a mercantile and craft center at the beginning of the eighteenth century. Its population grew rapidly from about 6,000 in 1700 to 15,000 in 1740 (Nash 1979:409). The lucrative triangular trade supported not only merchants and middlemen, but shipbuilders, coopers, blacksmiths, bakers, and other maritime-related craftsmen. As the century progressed, Boston's fortunes declined because of New England's heavy financial involvement in the long series of colonial wars. Although at first these wars brought economic benefit to Boston in the form of contracts for military provisions, privateering opportunities, and employment for craftspeople and the poor, the aftermath left the city and the colony heavily in debt, the economy depressed, inflation rampant, and poorhouses and poor-relief roles bulging with widows and fatherless children. By the French and Indian War (1754-1761), the advantages of the war were primarily experienced by a few military contractors. At the same time, New York and Philadelphia, whose military financial involvements were not so deep, eclipsed Boston in population and prosperity. The devastating fire of 1760, which raged for four days, was a further blow to the city (Nash 1979:17-21; 54-65; 102-111; 161-176; 241-247). The post-French and Indian War crackdown by Parliament on Colonial tax evaders threatened Boston's West Indian trade. By 1770, the effect of the wars on the wealth distribution in Boston was profound, since

"the top 5% of taxpayers and decendents with inventoried estates controlled about as much wealth as the other 95% combined" (Nash 1979:257).

In 1768, the British army occupied Boston, and in 1774 Parliament closed the Port of Boston and moved the Customs Office to Salem. This was the final blow to the economy, and precipitated the events leading to the Battles of Lexington and Concord. Although little fighting took place in Boston proper, the siege of Boston resulted in economic depression, destruction of property and loss of a significant portion of the population--namely, those Loyalists who left with the British.

In the Boston area, few pre-Revolutionary sites have been excavated or monitored (Bostonian Hotel, Wilkinson Block, Long Wharf). In Charlestown, the Chelsea-Water Street sites have been excavated. Archaeologists have noted an increasing stratification in Colonial urban society, as well as the influx of an increased quantity of consumer goods and designation of "private" space and individual possessions. Excavation and analysis of eighteenth-century domestic site remains would offer a comparison to 1) sites already excavated in Boston; 2) sites excavated in Charlestown; 3) other sites excavated in the Boston area and various New England ports such as Portsmouth, Newport and Salem.

Federal Port (1790-1830). Once the new Republic was established after the Revolution, Boston began to grow again, regaining its population, replacing houses and businesses, and accepting new community members, many from rural areas. The city expanded its maritime activities to the northwest coast, China, and Russia. The beginning of the industrial age saw Boston become the port and financial center for the surrounding manufacturing towns and cities. By the 1820s and 1830s, land-leveling and landfilling activities were changing the size and appearance of the Shawmut peninsula.

Archaeological remains of Federal Period domestic sites have been found in and around most major New England urban ports including Newport, Plymouth, Boston, Charlestown, Salem, Newburyport, and Portsmouth.

Additional Evaluation Criteria

One must understand not only the framework used in identifying and evaluating various materials, features, or sites within the project area, but why resources discovered at this site will be significant and thus justify further scientific study.

Much of what is important in an archaeological site is the data it contains. These data may (depending on our current state of knowledge) take three separate forms:

New Data. New data verify or contradict predictive models which are used in understanding the past for a variety of reasons, including teaching, interpretation, and resource management.

Corroborative Data. These data reinforce models and supplement interpretations derived from a number of sources.

Comparative Data. These data reinforce regional and national models as well as contributing to theoretical synthesis at the regional and national levels.

Using these classifications of data within a project area, it is possible to establish priorities for decision making when resources are discovered. The priorities follow the scheme outlined above in that "new data" may drastically modify current thinking and have a high priority for further study. For example, if a part of a major Contact Period site were discovered within the project area, our current understanding about the relationships of Contact Period native groups or their response to European "invasion" would have to be modified.

While not quite as earthshaking as new data, "corroborative data" are especially essential in the Boston area. This is due to the current inadequacy of data from many of the earlier periods for an even rudimentary understanding of the cultural history of the area.

"Comparative data" generally exist only when significant amounts are available for comparison with data bases in other regions. Thus this classification will only be assigned when we expect to obtain enough data from resources within the project area for comparison with other sources.

Appendix C Seasonal Wind Data

INTRODUCTION

As requested by the BRA, seasonal wind data for existing conditions and the currently proposed scheme are presented here, and compared with the annual velocity for each point tested. The seasonal changes displayed by Boston area winds are discussed in Section IV-D. In general, the predicted velocities are higher than the annual result for Winter and Spring, lower than the annual result in Summer, and about the same as the annual result in Fall.

EXHIBIT VI C-1 SEASONAL WIND DATA

Station	Condition	Effective Gust Velocity (mph)				
		Winter	Spring	Summer	Fall	Annual
1	Existing	28.1	25.9	19.1	23.4	25.0
	Proposed	27.7	25.4	18.7	22.8	24.5
2	Existing	30.7	29.2	21.5	26.8	28.1
	Proposed	32.6	20.1	22.0	27.3	29.1
3	Existing	18.9	19.2	15.8	18.5	18.3
	Proposed	22.1	22.9	17.5	21.9	21.5
4	Existing	28.5	26.4	19.6	24.2	25.5
	Proposed	25.6	23.7	17.5	21.7	22.9
5	Existing	22.0	20.7	15.9	19.8	20.3
	Proposed	21.5	20.9	15.8	20.0	20.2
6	Existing	18.1	17.4	13.2	16.7	16.9
	Proposed	18.3	17.2	12.9	15.8	16.7
7	Existing	22.3	20.9	16.0	19.7	20.4
	Proposed	21.1	19.8	15.1	18.7	19.4
8	Existing	17.9	16.6	12.7	14.5	16.1
	Proposed	19.2	17.4	13.2	15.2	17.0
9	Existing	25.5	26.6	18.8	25.4	24.7
	Proposed	26.4	27.3	19.4	26.0	25.5
10	Existing	23.5	24.8	17.1	23.6	22.8
	Proposed	24.6	25.9	18.1	24.4	24.0
13	Existing	12.0	12.5	9.4	12.1	11.7
	Proposed	13.5	14.2	12.3	13.3	13.4
15	Existing	17.3	18.7	13.0	17.4	17.1
	Proposed	16.9	18.7	13.0	17.1	16.8
16	Existing	13.6	13.9	9.9	12.9	12.8
	Proposed	13.9	14.4	10.4	13.2	13.2
17	Existing	16.2	15.1	11.3	14.1	14.7
	Proposed	18.8	17.6	13.2	16.1	17.0
18	Existing	8.6	8.2	6.3	7.8	8.0
	Proposed	13.7	13.7	10.5	13.2	13.0
19	Existing	18.9	17.9	13.3	17.0	17.4
	Proposed	21.5	20.5	15.3	19.8	19.9
20	Existing	20.5	18.8	14.3	17.0	18.2
	Proposed	17.8	17.3	13.4	16.1	16.6
21	Existing	15.6	16.2	12.4	15.6	15.1
	Proposed	16.3	16.7	13.0	16.0	15.7
22	Existing	12.7	12.2	9.3	11.7	11.8
	Proposed	13.1	13.0	10.4	12.3	12.5
23	Existing	21.2	22.7	15.8	21.6	20.9
	Proposed	15.3	15.5	12.0	14.9	14.7
24	Existing	27.1	28.8	20.1	27.3	26.6
	Proposed	27.2	29.0	20.3	27.4	26.7
25	Existing	14.4	14.7	11.0	13.7	13.7
	Proposed	16.4	16.0	12.8	15.2	15.4
26	Existing	14.3	14.1	11.1	13.1	13.4
	Proposed	15.2	15.2	12.1	14.3	14.5
27	Existing	22.7	24.3	16.8	23.0	22.3
	Proposed	22.8	24.0	16.9	22.6	22.2

Appendix D Previous Wind Studies

The following section summarizes wind studies which have been previously conducted to assess the effects of design alternatives considered prior to the scheme currently proposed. This information is presented for use in comparing effects of these previously considered schemes with those of the currently proposed design (discussed in Section IV-D).

PREVIOUS WIND STUDIES:
PHASE I HOT WIRE TESTING

INTRODUCTION

Hot wire wind analysis previously conducted in the Spring of 1985 assessed the effects of three design alternatives being considered at that time. This analysis was originally presented in the BRA Draft Environmental Assessment for this project (May 1985). Alternative 1 totalled 19 stories, and was comprised of a tower 263 feet in height, with a 116 foot-high base. Alternative 2 totalled 30 stories, and consisted of a 395 foot-high tower with a 67 foot base. Alternative 3 totalled 33 stories, and consisted of a 435 foot-high tower with a 67 foot base. The overall massing of Alternative 2 is most similar to the currently proposed project design, although the current scheme utilizes a greater tower setback from Kilby Street.

Sixteen locations were tested in the analysis, and are shown in Exhibit IV D-1. Text in this section summarizes changes in pedestrian-level wind velocities. Based upon data collected at the time of this testing, only changes in velocity of greater than 0.5 mph were considered to be statistically significant.

Following this text is a data summary concerning hot wire test findings for each of these alternatives. This data summary presents velocities in terms of average, peak, effective gust and equivalent average.

FINDINGS

Existing Conditions

Pedestrian-level wind conditions at sixteen stations in the vicinity of the project site were studied in the hot-wire test. For existing conditions these sixteen stations were found to experience moderate pedestrian-level wind conditions. Seven stations (8, 11, 12, 13, 14, 15, and 16) experience winds within Melbourne's "stationary long exposure" comfort category. Five stations (3, 5, 6, 7, and 9) fell within the "stationary short exposure" category, and four stations (1, 2, 4, and 10) experienced pedestrian-level winds "acceptable for walking." None of the stations exceeded the BRA guideline for the effective gust pedestrian-level wind velocity.

Exhibit VI D-1 Test Points - Phase I Hot Wire Analysis

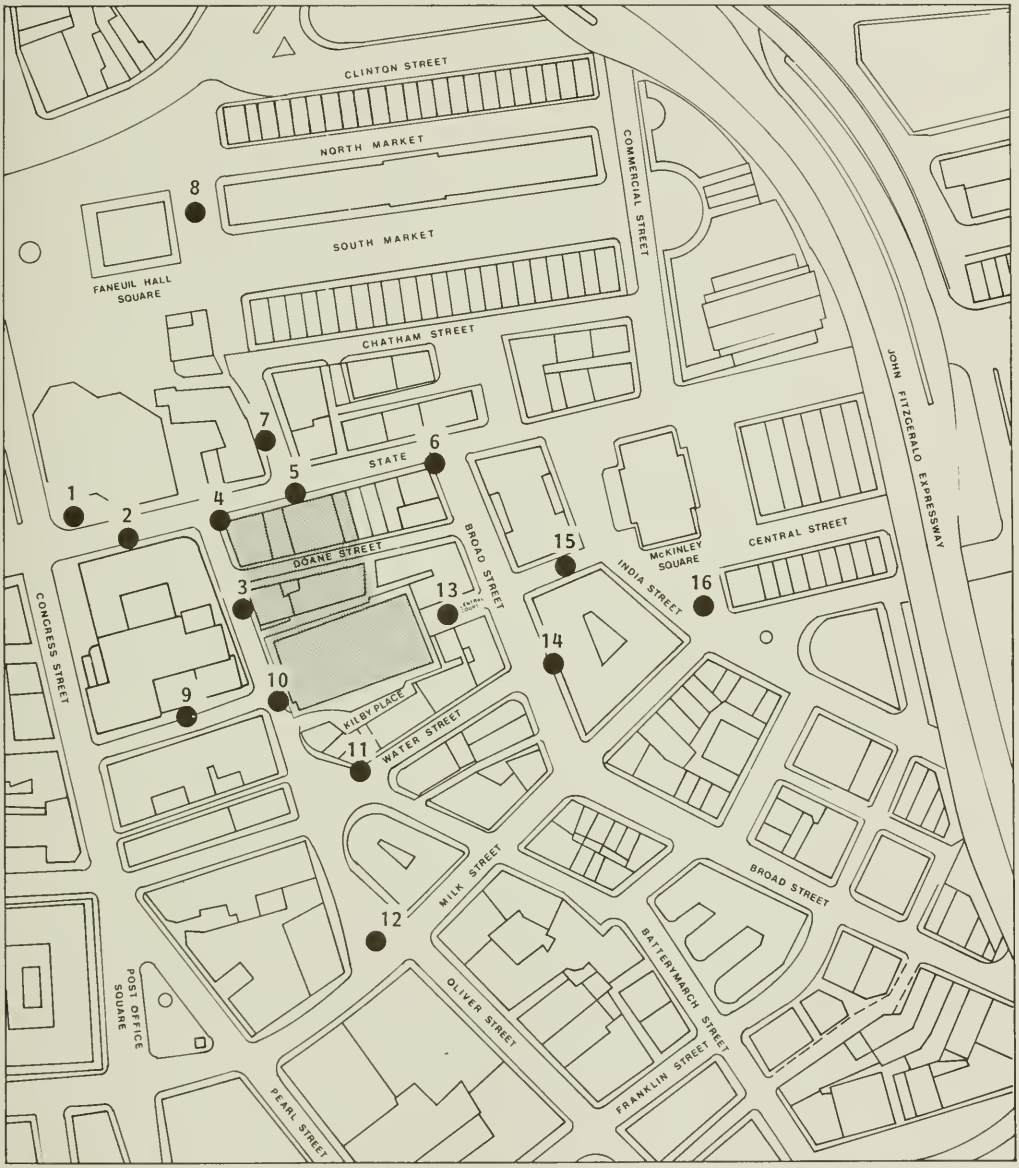


Exhibit VI D-2

19-STORY ALTERNATIVE - DATA SUMMARY

Test Points	Existing Conditions (MPH)					Proposed Development (MPH)				
	Average	Peak	Effective Gust	Equivalent Average	Melbourne Category	Average	Peak	Effective Gust	Equivalent Average	Melbourne Category
1	17.2	29.6	23.8	17.2	3	17.6	30.1	24.4	17.6	3
2	18.1	31.7	24.7	18.1	3	19.1	32.1	25.2	19.1	2
3	11.8	24.7	17.5	12.3	4	14.2	25.6	19.1	14.2	4
4	17.5	32.9	24.5	17.5	3	15.4	30.7	22.9	16.0	3
5	13.9	25.0	19.1	13.9	4	14.7	27.3	20.6	14.7	4
6	13.0	24.3	18.1	13.0	4	11.8	25.8	17.8	12.9	4
7	12.3	24.5	18.0	12.6	4	11.9	24.0	17.5	12.3	4
8	10.3	21.8	15.0	10.9	5	10.0	22.2	14.7	11.1	5
9	13.9	25.8	19.7	13.9	4	8.5	19.8	14.1	9.9	5
10	15.0	23.9	19.4	15.0	3	20.9	30.0	25.8	20.9	2
11	7.8	17.8	12.0	8.9	5	9.4	18.8	13.6	9.5	5
12	11.4	22.2	16.5	11.5	5	11.2	22.6	16.4	11.5	5
13	6.6	17.3	11.0	8.6	5	5.9	14.6	9.8	7.3	5
14	4.5	14.1	8.3	7.1	5	6.8	16.2	11.1	8.1	5
15	9.7	21.2	14.4	10.6	5	9.7	21.8	15.3	10.9	5
16	5.8	18.6	10.5	9.3	5	6.2	18.7	11.0	9.3	5

Exhibit VI D-2

19-STORY ALTERNATIVE - CALCULATION OF CHANGES IN VELOCITY

Test Points	Effective Gust (MPH)			Equivalent Average (MPH)		
	Existing	Proposed Development	Change	Existing	Proposed Development	Change
1	23.8	24.4	+ .6	17.2	17.6	+0.4
2	24.7	25.2	+ .5	18.1	19.1	+1.0
3	17.5	19.1	+1.6	12.3	14.2	+1.9
4	24.5	22.9	-1.6	17.5	16.0	-1.5
5	19.1	20.6	+1.5	13.9	14.7	+0.8
6	18.1	17.8	- .3	13.0	12.9	-0.1
7	18.0	17.5	- .5	12.6	12.3	-0.3
8	15.0	14.7	- .3	10.9	11.1	+0.2
9	19.7	14.1	-5.6	13.9	9.9	-4.0
10	19.4	25.8	+6.4	15.0	20.9	+5.9
11	12.0	13.6	+1.6	8.9	9.5	+0.6
12	16.5	16.4	- .1	11.5	11.5	0.0
13	11.0	9.8	-1.2	8.6	7.3	-1.3
14	8.3	11.1	+2.8	7.1	8.1	+1.0
15	14.4	15.3	+ .9	10.6	10.9	+0.3
16	10.5	11.0	+ .5	9.3	9.3	0.0

19-Story Alternative

With Alternative 1 in place, nine stations (1, 2, 3, 5, 8, 10, 11, 14, and 15) in the vicinity of the project experienced increased pedestrian-level wind velocities. Only six of these nine stations demonstrated changes in velocity greater than 0.5 mph (stations 2, 3, 5, 10, 11, and 14). Five stations (4, 6, 7, 9, and 13) experienced decreased velocities. Three of these five stations experienced decreases in velocity that were greater than 0.5 mph (stations 4, 9, and 13). Two stations (12 and 16) experienced velocities that were equal to those experienced under existing conditions. Under the assumption that changes in velocity of greater than 0.5 mph are insignificant, a total of seven stations (1, 6, 7, 8, 12, 15 and 16) demonstrated pedestrian level wind conditions that were unchanged from existing conditions.

According to Melbourne's criteria, one station (9) became more comfortable, reaching the level for "stationary long exposure." Two stations (2 and 10) moved from "acceptable for walking" to "uncomfortable for walking." However, none of the stations exceeded the BRA guideline for effective gust with Alternative 1 in place.

30-Story Alternative

With Alternative 2 in place, ten stations (1, 2, 3, 5, 7, 8, 10, 11, 12, and 14) experienced increased wind velocities. Seven of those stations demonstrated increases of a significant magnitude greater than 0.5 mph (stations 2, 3, 5, 7, 10, 11, and 14). The remaining six stations (4, 6, 9, 13, 15, and 16) all experienced decreased pedestrian-level wind speeds, with five of those six stations demonstrating changes in velocity greater than 0.5 mph (stations 4, 6, 9, 13, and 15). A total of four stations (1, 8, 12, and 16) demonstrated pedestrian-level wind conditions which changed less than 0.5 mph, and were thus considered unchanged.

Two of the stations (6 and 9) that demonstrated decreased wind speeds experienced conditions which placed them in Melbourne's category "stationary long exposure." Three stations (2, 5, and 10) experienced conditions which moved them to less acceptable

Melbourne's criteria levels. None of the stations exceeded the BRA Guideline for effective gust with Alternative 2 in place.

33-Story Alternative

With Alternative 3 in place, seven stations (2, 3, 5, 7, 10, 11, and 14) experienced increased pedestrian-level wind velocities, with all of these stations demonstrating increases in magnitude greater than 0.5 mph. Eight stations (1, 4, 6, 8, 9, 13, 15, and 16) experienced decreased wind velocities. Of those eight stations, four demonstrated changes that were greater than 0.5 mph (stations 4, 6, 9, and 15). One station (12) did not experience any change in pedestrian-level wind velocity. A total of five stations (1, 8, 12, 13, and 16) demonstrated pedestrian-level wind conditions which changed less than 0.5 mph and were thus considered unchanged.

Two stations (6 and 9) experienced improved wind conditions enabling them to move to Melbourne's criteria level of "stationary long exposure." Two other stations (2 and 10) moved to a less acceptable Melbourne's criteria level. As with Alternatives 1 and 2, no stations were made to exceed the BRA guideline for effective gust with Alternative 3 in place.

Exhibit VI D-2

30-STORY ALTERNATIVE - DATA SUMMARY

Test Points	Existing Conditions (MPH)					Proposed Development (MPH)				
	Average	Peak	Effective Gust	Equivalent Average	Melbourne Category	Average	Peak	Effective Gust	Equivalent Average	Melbourne Category
1	17.2	29.6	23.8	17.2	3	17.3	30.1	23.9	17.3	3
2	18.1	31.7	24.7	18.1	3	19.9	32.0	26.0	19.9	2
3	11.8	24.7	17.5	12.3	4	13.3	25.2	18.2	13.3	4
4	17.5	32.9	24.5	17.5	3	16.2	31.3	23.7	16.6	3
5	13.9	25.0	19.1	13.9	4	15.0	28.0	20.7	15.0	3
6	13.0	24.3	18.1	13.0	4	10.1	22.3	15.8	11.2	5
7	12.3	24.5	18.0	12.6	4	12.4	25.3	18.7	13.1	4
8	10.3	21.8	15.0	10.9	5	10.1	22.4	15.1	11.2	5
9	13.9	25.8	19.7	13.9	4	8.9	21.1	14.4	10.6	5
10	15.0	23.9	19.4	15.0	3	20.1	29.5	25.0	20.1	2
11	7.8	17.8	12.0	8.9	5	11.2	20.5	15.2	11.2	5
12	11.4	22.2	16.5	11.5	5	11.6	22.8	16.5	11.6	5
13	6.6	17.3	11.0	8.6	5	7.1	16.0	10.9	8.0	5
14	4.5	14.1	8.3	7.1	5	7.7	18.8	12.4	9.4	5
15	9.7	21.2	14.4	10.6	5	6.4	17.0	10.9	8.5	5
16	5.8	18.6	10.5	9.3	5	5.9	17.9	10.6	8.9	5

30-STORY ALTERNATIVE - CALCULATION OF CHANGES IN VELOCITY

Test Points	Effective Gust (MPH)			Equivalent Average (MPH)		
	Existing	Proposed Development	Change	Existing	Proposed Development	Change
1	23.8	23.9	+ .1	17.2	17.3	+0.1
2	24.7	26.0	+1.3	18.1	19.9	+1.8
3	17.5	18.2	+ .7	12.3	13.3	+1.0
4	24.5	23.7	- .8	17.5	16.6	-0.9
5	19.1	20.7	+1.6	13.9	15.0	+1.1
6	18.1	15.8	-2.3	13.0	11.2	-1.8
7	18.0	18.7	+ .7	12.6	13.1	+0.5
8	15.0	15.1	+ .1	10.9	11.2	+0.3
9	19.7	14.4	-5.3	13.9	10.6	-3.3
10	19.4	25.0	+5.6	15.0	20.1	+5.1
11	12.0	15.2	+3.2	8.9	11.2	+2.3
12	16.5	16.5	0.0	11.5	11.6	+0.1
13	11.0	10.9	- .1	8.6	8.0	-0.6
14	8.3	12.4	+4.1	7.1	9.4	+2.3
15	14.4	10.9	-3.5	10.6	8.5	-2.1
16	10.5	10.5	0.0	9.3	8.9	-0.4

Exhibit VI D-2

33-STORY ALTERNATIVE - DATA SUMMARY

Test Points	Existing Conditions (MPH)					Proposed Development (MPH)				
	Average	Peak	Effective Gust	Equivalent Average	Melbourne Category	Average	Peak	Effective Gust	Equivalent Average	Melbourne Category
1	17.2	29.6	23.8	17.2	3	17.0	30.9	23.8	17.0	3
2	18.1	31.7	24.7	18.1	3	19.7	32.7	26.3	19.7	2
3	11.8	24.7	17.5	12.3	4	13.6	25.2	18.7	13.6	4
4	17.5	32.9	24.5	17.5	3	16.1	31.7	23.4	16.4	3
5	13.9	25.0	19.1	13.9	4	14.5	26.8	20.3	14.5	4
6	13.0	24.3	18.1	13.0	4	10.6	23.3	16.5	11.7	5
7	12.3	24.5	18.0	12.6	4	12.6	25.3	18.9	13.2	4
8	10.3	21.8	15.0	10.9	5	10.2	21.4	14.9	10.7	5
9	13.9	25.8	19.7	13.9	4	9.1	21.4	15.1	10.7	5
10	15.0	23.9	19.4	15.0	3	19.8	28.7	24.1	19.8	2
11	7.8	17.8	12.0	8.9	5	10.9	20.5	14.8	10.9	5
12	11.4	22.2	16.5	11.5	5	11.5	22.2	16.4	11.5	5
13	6.6	17.3	11.0	8.6	5	7.7	16.6	11.4	8.3	5
14	4.5	14.1	8.3	7.1	5	7.6	18.5	12.3	9.2	5
15	9.7	21.2	14.4	10.6	5	6.3	16.7	10.6	8.3	5
16	5.8	18.6	10.5	9.3	5	5.4	18.1	9.8	9.0	5

33-STORY ALTERNATIVE - CALCULATION OF CHANGES IN VELOCITY

Test Points	Effective Gust (MPH)			Equivalent Average (MPH)		
	Existing	Proposed Development	Change	Existing	Proposed Development	Change
1	23.8	23.8	0.0	17.2	17.0	-0.2
2	24.7	26.3	+1.6	18.1	19.7	+1.6
3	17.5	18.7	+1.2	12.3	13.6	+1.3
4	24.5	23.4	-1.1	17.5	16.4	-1.1
5	19.1	20.3	+1.2	13.9	14.5	+0.6
6	18.1	16.5	-1.6	13.0	11.7	-1.3
7	18.0	18.9	+ .9	12.6	13.2	+0.6
8	15.0	14.9	- .1	10.9	10.7	-0.2
9	19.7	15.1	-4.6	13.9	10.7	-3.2
10	19.4	24.1	+4.7	15.0	19.8	+4.8
11	12.0	14.8	+2.8	8.9	10.9	+2.0
12	16.5	16.4	-0.1	11.5	11.5	0.0
13	11.0	11.4	+0.4	8.6	8.3	-0.3
14	8.3	12.3	+4	7.1	9.2	+2.1
15	14.4	10.6	-3.8	10.6	8.3	-2.3
16	10.5	9.8	- .7	9.3	9.0	-0.3

PREVIOUS WIND STUDIES:
PHASE II HOT WIRE TESTING - JUNE 3 SCHEME

INTRODUCTION

During the second phase of hot-wire wind analysis, which included evaluation of the currently proposed project design, an additional design alternative which was then being considered was tested as well. This alternative is referred to here as the June 3 Scheme. The design consists of the same overall height and general massing as the currently proposed scheme, but with a tower setback from Kilby Street of approximately one-half of that of the current design. Points tested are the same as those shown in Exhibit VI D-1. Data is summarized in Exhibit VI D-2, listing existing and predicted velocities for the design scheme in terms of average, peak, effective gust and equivalent average. Based upon the data collected at the Wright Brothers Wind Tunnel, changes in velocity of greater than 0.6 mph are considered to be statistically insignificant. Therefore, pedestrian-level wind conditions at stations that experience a difference of less than 0.6 mph were considered to remain unchanged.

FINDINGS

Existing Conditions

Pedestrian-level wind conditions at 24 stations in the vicinity of the project site were studied in the hot-wire test, and are shown in Exhibit VI D-2. All of the stations utilized in the initial hot wire analysis (see previous section of this appendix) were retested, with the exception of stations 11, 12 and 14. Eleven new points were added, stations 17-27.

For existing conditions, these 24 stations were found to experience moderate pedestrian-level wind conditions. As measured by effective gust, none of the stations tested exceed the BRA wind guideline. In terms of Melbourne's Criteria, as measured by equivalent average, the existing conditions can be categorized as shown on the following page:

Melbourne Category		Stations Tested
1	Unacceptable/Dangerous	None
2	Uncomfortable for Walking	2, 24
3	Acceptable for Walking	1, 4, 9, 10, 27
4	Stationary Short Exposure	3, 5, 6, 7, 15, 19, 20, 23
5	Stationary Long Exposure	8, 13, 16, 17, 18, 21, 22, 25, 26

Probable Project Impacts

The data evaluated from the hot-wire test for pedestrian-level winds in the vicinity of the project site compares changes in both effective gust velocity and equivalent average velocity between existing conditions and future conditions after proposed development. Under the assumption that changes in velocity of less than 0.6 mph are not significant, pedestrian-level wind conditions resulting from this previously considered design scheme will not change or will be reduced at a majority of stations in the vicinity of the project site, as measured by either effective gust or equivalent average. These changes are shown in Exhibit VI D-2.

At no locations tested does this design scheme result in pedestrian-level wind conditions which exceed the BRA wind guideline of a maximum effective gust velocity of 31 mph. In terms of effective gust, 11 stations experienced increased velocities, 6 stations experienced decreased velocities, and 7 stations remained unchanged.

In terms of equivalent average, 9 stations increased, 5 stations decreased, and 10 stations remained unchanged. As shown below, at no stations was Melbourne's category of "unacceptable/dangerous" found to exist. Most stations fell within Melbourne's criteria for "acceptable for walking, stationary short exposure and stationary long exposure."

Exhibit VI D-2

JUNE 3 SCHEME - DATA SUMMARY

Test Points	Existing Conditions (MPH)					Proposed Development (MPH)				
	Average	Peak	Effective Gust	Equivalent Average	Melbourne Category	Average	Peak	Effective Gust	Equivalent Average	Melbourne Category
1	17.1	32.0	24.9	17.4	3	17.2	31.6	24.8	17.4	3
2	20.9	33.5	28.0	20.9	2	20.4	31.9	27.0	20.4	2
3	12.2	23.9	18.3	12.8	4	16.9	25.7	21.5	16.9	3
4	18.1	32.7	25.5	18.1	3	15.5	31.0	22.8	16.0	3
5	14.1	27.7	20.1	14.1	4	13.3	26.9	18.9	13.5	4
6	11.0	25.7	16.7	12.8	4	8.6	23.7	14.3	11.9	5
7	13.8	26.2	20.0	14.0	4	12.3	25.2	18.3	12.8	4
8	11.2	22.8	16.1	11.4	5	11.4	22.5	16.1	11.4	5
9	18.9	29.5	24.7	18.9	3	20.5	30.0	26.1	20.5	2
10	17.8	27.1	22.8	17.8	3	21.1	29.6	25.7	21.1	2
13	7.4	18.6	11.7	9.3	5	8.7	18.0	12.5	9.0	5
15	11.6	24.6	17.1	12.3	4	11.4	24.4	17.0	12.2	4
16	7.4	23.3	12.8	11.7	5	7.4	21.8	12.9	10.9	5
17	10.0	22.4	14.6	11.2	5	11.7	24.4	17.5	12.2	4
18	4.7	13.1	7.9	6.6	5	9.4	18.0	13.5	9.5	5
19	11.9	23.8	17.3	12.1	4	15.2	25.2	20.1	15.2	3
20	12.1	23.6	18.1	12.7	4	12.0	23.2	17.7	12.4	4
21	10.0	22.3	15.1	11.1	5	10.3	23.5	15.7	11.7	5
22	7.2	18.1	11.7	9.0	5	7.7	19.6	12.5	9.8	5
23	14.0	27.4	20.9	14.6	4	9.8	23.4	15.6	11.7	5
24	20.5	31.9	26.6	20.5	2	20.3	31.4	26.3	20.3	2
25	8.6	21.7	13.7	10.9	5	11.0	22.6	16.2	11.3	5
26	8.3	22.5	13.4	11.3	5	10.1	24.0	15.4	12.0	4
27	17.8	25.7	22.3	17.8	3	19.4	26.8	23.9	19.4	2

Exhibit VI D-2 JUNE 3 SCHEME - CALCULATION OF CHANGES IN VELOCITY

Test Points	Effective Gust (MPH)			Equivalent Average (MPH)		
	Existing	Proposed Development	Change	Existing	Proposed Development	Change
1	24.9	24.8	-0.1	17.4	17.4	0
2	28.0	27.0	-1.0	20.9	20.4	-0.5
3	18.3	21.5	+3.2	12.8	16.9	+4.1
4	25.5	22.8	-2.7	18.1	16.0	-2.1
5	20.1	18.9	-1.2	14.1	13.5	-0.6
6	16.7	14.3	-2.4	12.8	11.9	-0.9
7	20.0	18.3	-1.7	14.0	12.8	-1.2
8	16.1	16.1	0	11.4	11.4	0
9	24.7	26.1	+1.4	18.9	20.5	+1.6
10	22.8	25.7	+2.9	17.8	21.1	+3.3
13	11.7	12.5	+0.8	9.3	9.0	-0.3
15	17.1	17.0	-0.1	12.3	12.2	-0.1
16	12.8	12.9	+0.1	11.7	10.9	-0.8
17	14.6	17.5	+2.9	11.2	12.2	+1.0
18	7.9	13.5	+5.6	6.6	9.5	+2.9
19	17.3	20.1	+2.8	12.1	15.2	+3.1
20	18.1	17.7	-0.4	12.7	12.4	-0.3
21	15.1	15.7	+0.6	11.1	11.7	+0.6
22	11.7	12.5	+0.8	9.0	9.8	+0.8
23	20.9	15.6	-5.3	14.6	11.7	-2.9
24	26.6	26.3	-0.3	20.5	20.3	-0.2
25	13.7	16.2	+2.5	10.9	11.3	+0.4
26	13.4	15.4	+2.0	11.3	12.0	+0.7
27	22.3	23.9	+1.6	17.8	19.4	+1.6

At five stations (2, 9, 10, 24, 27), Melbourne's "uncomfortable for walking" category applied. Two of these stations (2, 24) were already in this category under existing conditions, and were affected only slightly by proposed development. The other three stations (9, 10, 27) were almost within this category under existing conditions, and were increased only slightly by this design scheme. These points have been categorized within Melbourne's criteria according to equivalent average velocity figures because such figures reflect worst-case conditions. However, if categorized according to effective gust figures, stations 2, 9, 10, 24 and 27 would all be within category 3, "acceptable for walking."

Future conditions under this design scheme are shown below as categorized by Melbourne's critiera:

Melbourne Category		Stations Tested
1	Unacceptable/Dangerous	None
2	Uncomfortable for Walking	2, 9, 10, 24, 27
3	Acceptable for Walking	1, 3, 4, 19
4	Stationary Short Exposure	5, 7, 15, 17, 20, 26
5	Stationary Long Exposure	8, 13, 16, 18, 21, 22, 23, 25

Appendix E Previous Shadow Studies

INTRODUCTION

In addition to the shadow studies presented in Section IV-E, shadow analysis has also been conducted for two previously considered alternatives described in detail in the Draft BRA Environmental Assessment (May 1985). At the request of the BRA, this previously conducted analysis is presented here for purposes of comparison with the currently proposed scheme.

These alternatives consist of a 19-story scheme 263 feet in height, and a 33-story scheme 435 feet in height. The project-generated shadows cast by the two schemes were evaluated and compared to existing conditions. No significant shadow impacts were found to occur as a result of these development alternatives.

Shadow analyses were conducted for three times of day--9:00 am, Noon and 3:00 pm for the following days:

- o March 21 (Vernal Equinox, average shadow conditions equivalent to those on September 21, the Autumn Equinox)
- o June 21 (Summer Solstice, minimum shadow conditions, conducted under daylight savings time conditions)
- o December 21 (Winter Solstice, maximum shadow conditions)

PROBABLE PROJECT IMPACTS

March 21 (Vernal Equinox)

19-Story Alternative

- o 9:00 am - As compared to existing conditions, the proposed building produces a new shadow at the entrance to 60 State Street, filling a small gap between two larger shadows.
- o Noon - No new shadow
- o 3:00 pm - No new shadow

33-Story Alternative

- 9:00 am - As compared to existing conditions, the proposed building produces a new shadow at the entrance to 60 State Street in addition to producing a small area of new shadow over Congress Street north of State Street.

- Noon - No new shadow

- 3:00 pm - As compared to existing conditions, the proposed building produces a small shadow to the south of Marketplace Center.

June 21, Summer Solstice

19-Story Alternative

- 9:00 am - No new shadow.

- Noon - As compared to existing conditions, the proposed building casts a shadow on the roof of its base element, and on a small portion of the sidewalk at the corner of Kilby and State Streets.

- 3:00 pm - As compared to existing conditions, the proposed building produces a new shadow on Broad Street.

33-Story Alternative

- 9:00 am - No new shadow.

- Noon - As compared to existing conditions, the proposed building casts a shadow on the roof of its base element, and on a small portion of the sidewalk at the corner of Kilby and State Streets.

- 3:00 pm - The proposed building casts a new shadow primarily on Broad Street and Central Street.

December 21, Winter Solstice

19-Story Alternative

- 9:00 am - The proposed building casts a small new shadow on Congress Street adjacent to a large existing shadow.

- Noon - No new shadow.

- 3:00 pm - The proposed project casts a small new shadow on the Harbor side of the Expressway.

33-Story Alternative

- 9:00 am - The proposed building produces an approximately 15 foot sliver of new shadow on Congress Street and the eastern-most portion of City Hall Plaza which is otherwise completely in shadow now.

- Noon - No new shadow.

- 3:00 pm - The proposed project casts a shadow on Commercial Wharf and Lewis Wharf.

Exhibit VI E-1 PROJECT AREA SHADOW CONDITIONS

19-Story Alternative
March 21
9:00 am

Existing Shadow

New Shadow

Exhibit VI E-1

PROJECT AREA SHADOW CONDITIONS

19-Story Alternative
March 21
12:00 noon

Existing Shadow

New Shadow

No New Shadow

Exhibit VI E-1

PROJECT AREA SHADOW CONDITIONS

19-Story Alternative
March 21
3:00 pm

Existing Shadow

New Shadow

No new shadow

Exhibit VI E-1 PROJECT AREA SHADOW CONDITIONS

19-Story Alternative
June 21
9:00 am

Existing Shadow

New Shadow

No new shadow

19-Story Alternative
June 21
12:00 noon

Existing Shadow

New Shadow

Exhibit VI E-1 PROJECT AREA SHADOW CONDITIONS

19-Story Alternative
June 21
3:00 pm

Existing Shadow
New Shadow

Exhibit VI E-1

PROJECT AREA SHADOW CONDITIONS

19-Story Alternative
December 21
9:00 am

Existing Shadow

New Shadow

Exhibit VI E-1

PROJECT AREA SHADOW CONDITIONS

19-Story Alternative
December 21
12:00 noon

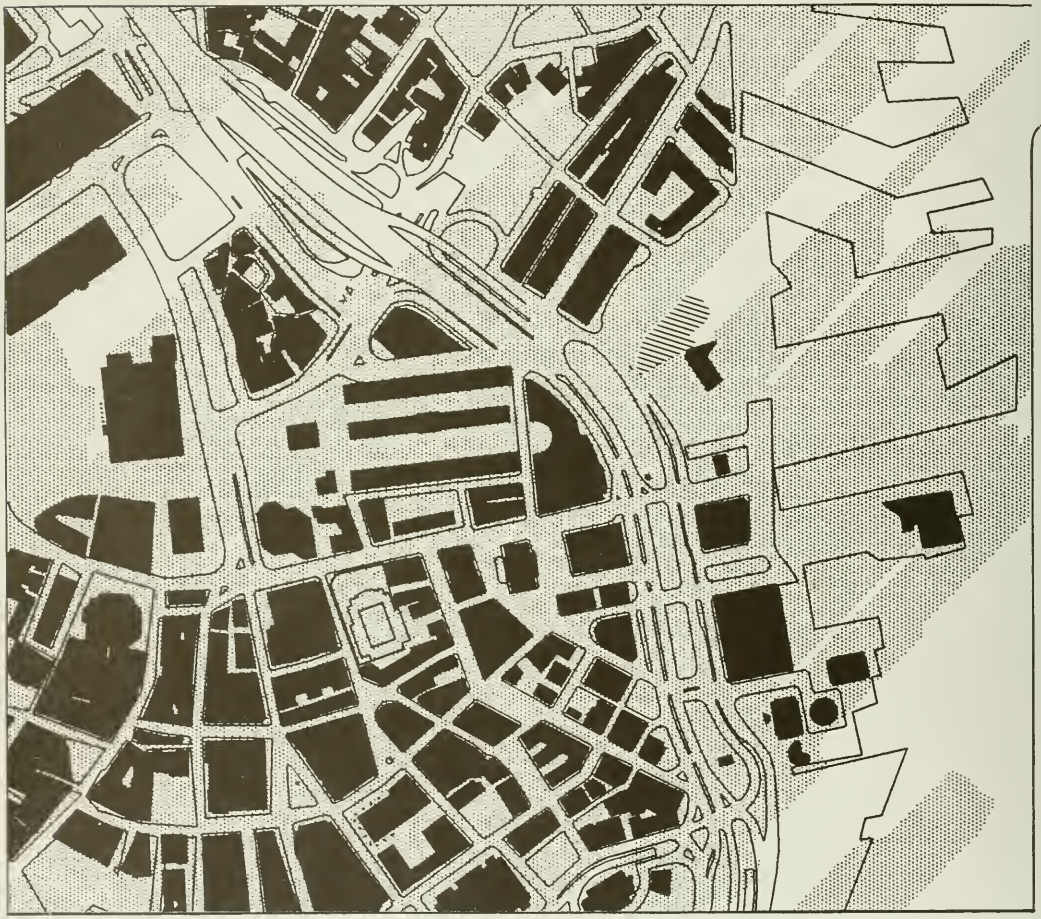
Existing Shadow

New Shadow

No New Shadow

Exhibit VI E-1

PROJECT AREA SHADOW CONDITIONS



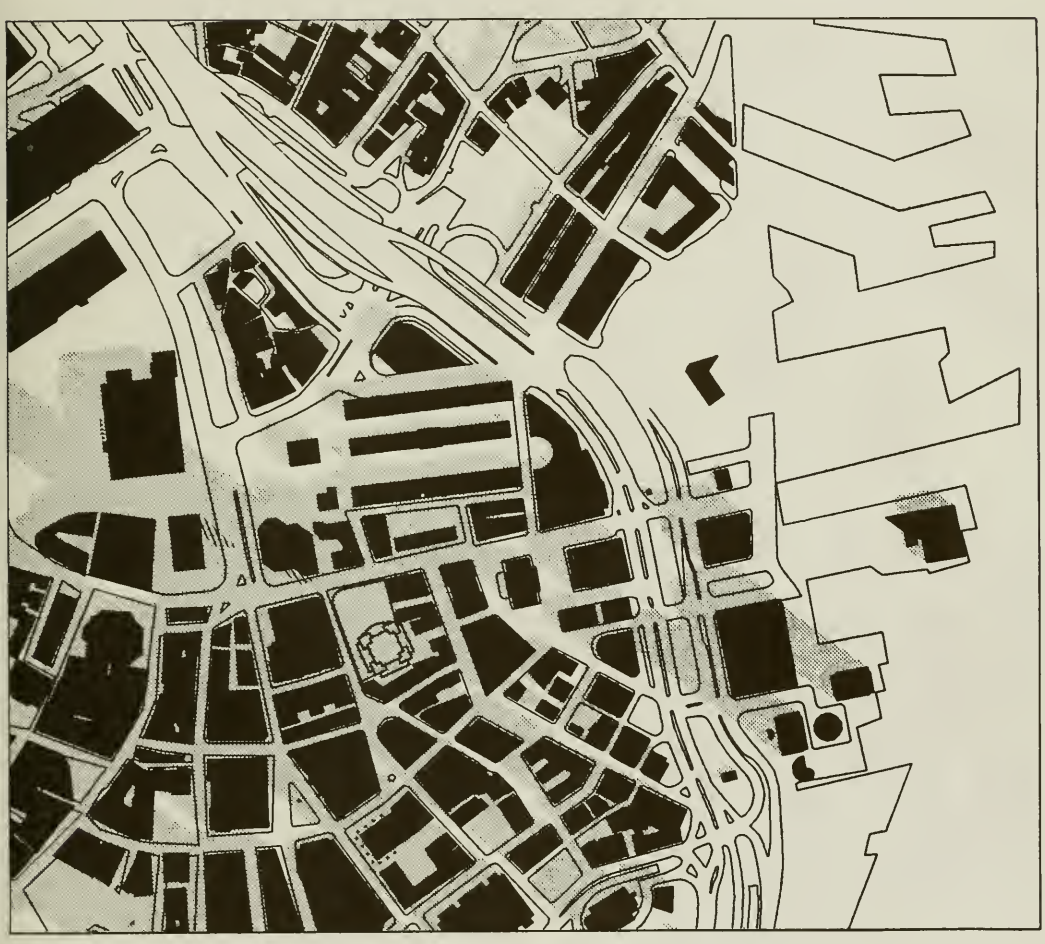
19-Story Alternative
December 21
3:00 pm

Existing Shadow

New Shadow

Exhibit VI E-1

PROJECT AREA SHADOW CONDITIONS



33-Story Alternative
March 21
9:00 am

Existing Shadow

New Shadow

Exhibit VI E-1

PROJECT AREA SHADOW CONDITIONS

33-Story Alternative
March 21
12:00 noon

Existing Shadow

New Shadow

No New Shadow

PROJECT AREA SHADOW CONDITIONS

33-Story Alternative
March 21
3:00 pm

Existing Shadow

New Shadow

Exhibit VI E-1 PROJECT AREA SHADOW CONDITIONS

33-Story Alternative
June 21
9:00 am

Existing Shadow

New Shadow

No new shadow

Exhibit VI E-1 PROJECT AREA SHADOW CONDITIONS

33-Story Alternative
June 21
12:00 noon

Existing Shadow

New Shadow

Exhibit VI E-1 PROJECT AREA SHADOW CONDITIONS

33-Story Alternative
June 21
3:00 pm

Existing Shadow
New Shadow

PROJECT AREA SHADOW CONDITIONS

33-Story Alternative
December 21
9:00 am

Existing Shadow

New Shadow

PROJECT AREA SHADOW CONDITIONS

33-Story Alternative
December 21
12:00 noon

Existing Shadow

New Shadow

No New Shadow

PROJECT AREA SHADOW CONDITIONS

33-Story Alternative
December 21
3:00 pm

Existing Shadow

New Shadow

Appendix F Air Quality Data

The following section provides a detailed explanation regarding the methodology utilized to conduct the air quality analysis presented in Section IV-B. The section also presents computer modeling output for emissions and air pollution concentrations which were utilized in the analysis.

METHODOLOGY FOR THE INTERSECTION ANALYSIS

The microscale analysis predicted maximum 1-hour and 8-hour CO concentrations at three receptors near the intersection of State Street and Broad Street in the study area for the following three cases:

Case No.	Year	Build Alternative
1	1985	Existing Conditions
2	1990	No-Build
3	1990	Build

In all cases, the EPA MOBILE-3 computer program was used to calculate emissions and the CALINE-3 dispersion model was used to predict concentrations supplemented by a set of assumptions endorsed by the Department of Environmental Quality Engineering (DEQE) for urban area analysis. These assumptions include an ambient air temperature of 33°F (December), and worst-case meteorological conditions of Pasquill-Gifford Class D stability in conjunction with a 1.0 meters per second (m/s) wind speed (1-hour) and a 1.6 m/s wind speed (8-hour), the worst-case wind direction (determined by analyzing all directions at 10 degree increments), a mixing height of 1,000 meters, a roughness length of 321 cm (for downtown urban areas), and a vehicle spacing of 6 meters.

The CO background levels for 1985 in the project area were assumed to be 5.0 ppm (1-hour) and 3.0 ppm (8-hour). The 1990 background levels were scaled from 1985 values by the fractional decrease in emission rates and the fractional increase in traffic.

The CO emission rates used in this analysis decrease at least 37 percent from 1985 to 1990 (see section on calculation of emission rates in this Appendix). In the same time period, peak hour traffic at the intersection will grow 33 percent from 1985 to the 1990 No-Build case. Thus, the calculated 1990 CO background levels are 4.2 ppm (1-hour) and 2.5 ppm (8-hour).

The EPA Region I Mobile Source Modeling Procedures[1] describe the proper use of the CALINE-3 dispersion model in a microscale analysis for free-flow and queueing emissions from motor vehicles at an intersection. EPA has programmed these procedures with the CALINE-3 model in a software package called CALQ3. CALQ3 was used in this analysis. The complete CALQ3 computer modeling output is included at the end of this Appendix.

Multiple receptors were used at the intersection and were placed based on land use considerations, i.e., where the public has access and is expected to be for periods of time. Receptors are placed at least three meters from the edge of the nearest travel lane so that they are not within the roadway mixing cell, and a receptor height of 1.8 meters is assumed.

The analysis utilized peak 1-hour and 8-hour traffic volumes. Based on the 1990 Build volume subject to queuing at the stop sign on Broad Street, the peak hour is in the afternoon. Peak 8-hour volumes were estimated by applying a reduction factor of 0.70 to the peak hour volumes. This factor was developed for the nearby Surface Artery in the Rowes Wharf EIR, based on hourly traffic counts taken by Vanasse/Hangen Associates, Inc. Traffic volume and capacity data for the intersection represent peak conditions during a weekday and are presented in the traffic section of this EIR.

Calculation of Motor Vehicle CO Emission Rates

The EPA MOBILE-3 computer program was used to generate all CO emission rates used in this analysis. Roadway CO emission rates used in this study are based on the MOBILE-3 default national motor vehicle mix (see Table 1), an average December temperature of 33°F, and the 1983 Massachusetts registration distributions for seven vehicle types (see Table 2). The MOBILE-3 default national cold/hot start mix (presented

[1]EPA Region I, Region I Mobile Source Modeling Procedures, Boston, MA, January, 1985.

in Table 3) was used for determining roadway emissions during the peak 8-hour period. A mix with a higher cold start percentage for the evening rush hour was used to represent the peak 1-hour period. Emission rates are based on a travel speed of 20 mph for the non-queued portion of a vehicle's trip through each intersection and 15 mph for travel within the parking garage. Excess emissions due to idling in queues are also calculated by MOBILE-3. Emissions for a vehicle speed of 5 mph were used as idle-mode rates in this analysis since MOBILE-3 does not provide for calculation of idle rates using a cold/hot start vehicle mix. Emission rates used in this analysis assume a Statewide Inspection and Maintenance Program starting in 1983, with a 15 percent stringency factor and no machanic training for pre-1981 model years, and an idle test with cutpoints at 1.2 percent CO and 220 ppm HC for 1981 and later model years. Table 4 presents the composite CO emission rates for the peak 1-hour and 8-hour periods while Table 5 gives the idle emission rates used in the analysis. The complete MOBILE-3 output is found later in this Appendix.

TABLE 1
NATIONWIDE AVERAGE MOTOR VEHICLE MIX BY TYPE

Vehicle Type	Percent of VMT 1985	1990
Light-Duty Gasoline Vehicles (LDGV)	65.7	63.8
Light-Duty Gasoline Trucks		
0-6000 lb GVW* (LDGT1)	13.4	12.1
Over 6000 lb GVW (LDGT2)	9.2	9.1
Heavy-Duty Gasoline Trucks (HDGV)	3.6	3.6
Light-Duty Diesel Vehicles (LDDV)	2.1	4.4
Light-Duty Diesel Trucks (LDDT)	0.7	2.2
Heavy-Duty Diesel Trucks (HDDT)	4.6	4.1
Motorcycles (MC)	0.7	0.7
Total Percent	100.0	100.0

* Gross vehicle weight.

TABLE 2
1983 MASSACHUSETTS VEHICLE AGE DISTRIBUTIONS (percent)

Age (Years)	LDGV, LDDV	LDGT1, LDGT2, LDDT	HDGV HDDV
1	5.4	6.3	4.2
2	7.3	6.9	7.2
3	8.1	5.8	5.4
4	8.2	5.9	5.3
5	9.1	12.6	8.4
6	8.7	9.8	10.0
7	7.9	8.8	8.2
8	7.7	6.5	6.2
9	6.1	4.6	4.8
10	7.0	6.6	6.4
11	6.8	5.7	6.4
12	5.2	4.6	7.8
13	3.5	3.4	3.8
14	2.8	2.7	3.2
15	1.7	2.2	3.0
16	1.4	1.8	2.4
17	1.1	1.7	2.1
18	0.8	1.6	1.9
19	0.7	1.4	1.8
20+	0.5	1.1	1.5
Total	100.0	100.0	100.0

Auto registration as of July 1, 1983

Cars = 2,925,543
Trucks = 516,027

Source: Massachusetts Department of Environmental Quality Engineering.

TABLE 3
COLD/HOT START MIX FOR MOTOR VEHICLE EMISSIONS

	Intersection Analysis		Garage Analysis	
	1-Hour	8-Hour	1-Hour	8-Hour
Cold Start	50.0%	20.6%	100.0%	50.0%
Hot Start	10.0%	27.3%	0.0%	0.0%
Hot Stabilized	40.0%	52.1%	0.0%	50.0%
Total	100.0%	100.0%	100.0%	100.0%

TABLE 4
COMPOSITE CO EMISSION RATES

Time Period	Analysis	Emissions (grams/mile) 1985	1990
Peak 1-Hour	Intersection	81.03	51.03
	Garage	N/A	129.53
Peak 8-Hour	Intersection	52.07	32.96
	Garage	N/A	63.50

TABLE 5
IDLE EMISSION RATES FOR CO*
(grams/minute)

Time Period	1985	1990
Peak 1-Hour	19.91	10.21
Peak 8-Hour	12.91	6.69

* Idle emission rates are derived from MOBILE3 estimates for 5 mph. This approach is used to ensure the effects of cold and hot start engines are included in the idle emission rates.

METHODOLOGY FOR THE 99 STATE STREET PARKING GARAGE ANALYSIS

An analysis of the impacts of the ventilation system for the 99 State Street underground garage was conducted for the 1990 Build case.

Ventilation air from the six level, 700-space garage will be exhausted through a vent, ten feet above grade, on the south side of the building facing Kilby Place (the access drive to the truck loading area). The exhaust duct will be 125 square feet in area and carry a flow of 375,000 cubic feet/minute. Emissions of CO in the ventilation air were estimated from the traffic data in Table 6 using Worksheet 3 of the EPA Indirect Source Guideline Model, included at the end of this Appendix. The system will emit 4.88 g/s of CO for the peak 1-hour period and 1.58 g/s of CO for the peak 8-hour period.

TABLE 6
PARKING GARAGE TRAFFIC VOLUMES IN 1990
(Vehicles/Hour)

Peak 1-Hour		Peak 8-Hour	
Enter	Exit	Enter	Exit
50	329	88	157

The concentration of CO in the ventilation system exhaust was determined by the following formula:

$$X = 870\ (Q + (X_b)(F))/F$$

where: X = CO concentration in the ventilation exhaust (ppm)

Q = CO emission rate for the vent system (g/s)

X_b = Background concentration of CO in the makeup air assumed equal to the 1990 background concentrations used in this analysis (grams/cubic meter)

F = Volumetric flow rate (cubic meters/second)

Ambient concentrations at nearby receptors were scaled from the ventilation air concentrations using Halitsky's[2] empirical model for gas diffusion near buildings. This model states that the ambient concentration X_a equals:

$$X_a = X/D$$

where D is a dilution factor defined as follows:

$$D = 2.22\ M\ \{3.16 + \frac{0.1(S)}{(Ae)^{1/2}}\}^2\ \{\frac{V}{Ve}\}$$

The terms are defined as follows:

M = Building configuration factor, equal to 4.0 for receptors in the downwash cavity of the exhaust plume.

S = Shortest arc distance from source to receptor (m).

Ae = Area of the exhaust opening (square meters).

V = Ambient wind velocity (m/s).
= 1.0 m/s (1-Hour)
= 1.6 m/s (8-Hour)

Ve = Source exit velocity (m/s).

When a source is diluted into background air and D is large, a revised formula is:

$$X_a = X/D + X_b$$

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[2] Halitsky, J., "Gas Diffusion Near Buildings", Meteorology and Atomic Energy 1968, U.S. Department of Energy (NTIS TID-24190), 1968, pp. 221-225.

Impacts were analyzed at two sensitive receptors: (1) the fresh air intake duct for the project on the roof of the low-rise portion of the building, and (2) the nearest pedestrian area to the exhaust duct at the entrance to the project on Kilby Street. Model input parameters are given in Table 7.

TABLE 7
GAS DIFFUSION MODEL INPUT PARAMETERS
FOR THE PARKING GARAGE
VENTILATION SYSTEM

	Fresh Air Intake Receptor	Pedestrian Receptor
Source-Receptor Arc Distance (m)	85	17
1-Hour Dilution Factor	9.0	6.4
8-Hour Dilution Factor	14.4	10.2

MOBILE SOURCE EMISSIONS - 99 STATE STREET

I/M PROGRAM SELECTED:

START YEAR (JANUARY 1): 1983
PRE-1981 MYR STRINGENCY RATE: 15%
MECHANIC TRAINING PROGRAM?: NO
FIRST MODEL YEAR COVERED: 1969
LAST MODEL YEAR COVERED: 2020
VEHICLE TYPES COVERED: LDGV, LDGT1
1981 & LATER MYR TEST TYPE: IDLE
1981 & LATER MYR TEST CUTPOINTS: 1.2% ICO / 220 PPM IHC

TOTAL HC EMISSION FACTORS INCLUDE EVAPORATIVE HC EMISSION FACTORS.

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1985 I/M PROGRAM: YES AMBIENT TEMP: 33.0 (F) REGION: LOW
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0 ALTITUDE: 500. FT.

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPEEDS:	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	
VMT MIX:	0.657	0.134	0.092		0.036	0.021	0.007	0.046	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHAUST CO:	202.90	304.44	465.69	369.92	525.89	3.99	4.88	38.39	214.09	238.89

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1985 I/M PROGRAM: YES AMBIENT TEMP: 33.0 (F) REGION: LOW
ANTI-TAM. PROGRAM: NO OPERATING MODE: 100.0 / 0.0 /100.0 ALTITUDE: 500. FT.

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPEEDS:	15.0	15.0	15.0		15.0	15.0	15.0	15.0	15.0	
VMT MIX:	0.657	0.134	0.092		0.036	0.021	0.007	0.046	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHAUST CO:	181.01	270.32	362.20	307.63	245.94	2.81	3.46	19.10	129.40	198.95

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1985 I/M PROGRAM: YES AMBIENT TEMP: 33.0 (F) REGION: LOW
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0 ALTITUDE: 500. FT.

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPEEDS:	20.0	20.0	20.0		20.0	20.0	20.0	20.0	20.0	
VMT MIX:	0.657	0.134	0.092		0.036	0.021	0.007	0.046	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHAUST CO:	71.22	104.84	137.92	118.27	182.65	1.50	1.83	14.43	50.14	81.03

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1985 I/M PROGRAM: YES AMBIENT TEMP: 33.0 (F) REGION: LOW
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6 ALTITUDE: 500. FT.

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPEEDS:	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	
VMT MIX:	0.657	0.134	0.092		0.036	0.021	0.007	0.046	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHAUST CO:	123.88	187.17	294.55	230.77	525.89	3.48	4.28	38.39	132.07	154.97

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1985 I/M PROGRAM: YES AMBIENT TEMP: 33.0 (F) REGION: LOW
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 0.0 / 50.0 ALTITUDE: 500. FT.

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPEEDS:	15.0	15.0	15.0		15.0	15.0	15.0	15.0	15.0	
VMT MIX:	0.657	0.134	0.092		0.036	0.021	0.007	0.046	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHAUST CO:	88.12	131.44	178.40	150.51	245.94	1.89	2.30	19.10	64.98	102.00

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1985 I/M PROGRAM: YES AMBIENT TEMP: 33.0 (F) REGION: LOW
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6 ALTITUDE: 500. FT.

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPEEDS:	20.0	20.0	20.0		20.0	20.0	20.0	20.0	20.0	
VMT MIX:	0.657	0.134	0.092		0.036	0.021	0.007	0.046	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHAUST CO:	42.88	64.02	86.25	73.05	182.65	1.31	1.61	14.43	30.95	52.07

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1990 I/M PROGRAM: YES AMBIENT TEMP: 33.0 (F) REGION: LOW
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0 ALTITUDE: 500. FT.

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPEEDS:	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	
VMT MIX:	0.639	0.121	0.091		0.036	0.044	0.022	0.041	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHAUST CO:	101.49	159.05	265.97	204.85	311.18	4.06	4.62	33.15	210.52	122.49

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1990 I/M PROGRAM: YES AMBIENT TEMP: 33.0 (F) REGION: LOW
ANTI-TAM. PROGRAM: NO OPERATING MODE: 100.0 / 0.0 / 100.0 ALTITUDE: 500. FT.

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH

VEH. SPEEDS:	15.0	15.0	15.0		15.0	15.0	15.0	15.0	15.0	
VMT MIX:	0.639	0.121	0.091		0.036	0.044	0.022	0.041	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHAUST CO:	116.26	169.06	251.70	204.46	145.53	2.88	3.28	16.50	127.67	124.53

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1990 I/M PROGRAM: YES AMBIENT TEMP: 33.0 (F) REGION: LOW
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0 ALTITUDE: 500. FT.

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPEEDS:	20.0	20.0	20.0		20.0	20.0	20.0	20.0	20.0	
VMT MIX:	0.639	0.121	0.091		0.036	0.044	0.022	0.041	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHAUST CO:	45.99	65.38	98.25	79.46	108.08	1.53	1.74	12.46	49.37	51.03

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1990 I/M PROGRAM: YES AMBIENT TEMP: 33.0 (F) REGION: LOW
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6 ALTITUDE: 500. FT.

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPEEDS:	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	
VMT MIX:	0.639	0.121	0.091		0.036	0.044	0.022	0.041	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHAUST CO:	61.80	97.42	169.50	128.29	311.18	3.52	4.05	33.15	129.71	80.31

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1990 I/M PROGRAM: YES AMBIENT TEMP: 33.0 (F) REGION: LOW
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 0.0 / 50.0 ALTITUDE: 500. FT.

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPEEDS:	15.0	15.0	15.0		15.0	15.0	15.0	15.0	15.0	
VMT MIX:	0.639	0.121	0.091		0.036	0.044	0.022	0.041	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHAUST CO:	56.17	81.24	124.83	99.91	145.53	1.93	2.17	16.50	64.02	63.50

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1990 I/M PROGRAM: YES AMBIENT TEMP: 33.0 (F) REGION: LOW
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6 ALTITUDE: 500. FT.

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPEEDS:	20.0	20.0	20.0		20.0	20.0	20.0	20.0	20.0	
VMT MIX:	0.639	0.121	0.091		0.036	0.044	0.022	0.041	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHAUST CO:	27.86	39.83	62.41	49.50	108.08	1.32	1.52	12.46	30.42	32.96

EPA REGION I CAL03 INTERSECTION MODEL FOR CARBON MONOXIDE
ENHANCEMENTS FOR OVERCAPACITY QUEUING AND STOP SIGN CONTROL ADDED BY TECH ENVIRONMENTAL, INC.
CALINE3: CALIFORNIA LINE SOURCE DISPERSION MODEL - SEPTEMBER, 1979 VERSION PAGE 37

JOB: STATE STREET AND BROAD STREET RUN: CASE 1 1-HOUR

**** MAXIMUM CONCENTRATIONS FOR ALL WIND DIRECTIONS ****

RECEPTOR	COORDINATES (M) X	Y	Z	TOTAL + AMB (PPM)
1. CUNARO BUILDING	69.	87.	1.8	5.9
2. PAX COMPUTER CENTER	78.	61.	1.8	5.9
3. COPYMAX INC.	42.	62.	1.8	4.8

EPA REGION I CAL03 INTERSECTION MODEL FOR CARBON MONOXIDE
ENHANCEMENTS FOR OVERCAPACITY QUEUING AND STOP SIGN CONTROL ADDED BY TECH ENVIRONMENTAL, INC.
CALINE3: CALIFORNIA LINE SOURCE DISPERSION MODEL - SEPTEMBER, 1979 VERSION PAGE 74

JOB: STATE STREET AND BROAD STREET RUN: CASE 2 1-HOUR

**** MAXIMUM CONCENTRATIONS FOR ALL WIND DIRECTIONS ****

RECEPTOR	COORDINATES (M) X	Y	Z	TOTAL + AMB (PPM)
1. CUNARO BUILDING	69.	87.	1.8	3.4
2 PAX COMPUTER CENTER	78.	61.	1.8	3.2
3 COPYMAX INC.	42.	62.	1.8	2.2

EPA REGION I CAL03 INTERSECTION MODEL FOR CARBON MONOXIDE
ENHANCEMENTS FOR OVERCAPACITY QUEUING AND STOP SIGN CONTROL ADDED BY TECH ENVIRONMENTAL, INC.
CALINE3: CALIFORNIA LINE SOURCE DISPERSION MODEL - SEPTEMBER, 1979 VERSION PAGE 111

JOB: STATE STREET AND BROAD STREET RUN: CASE 3 1-HOUR

**** MAXIMUM CONCENTRATIONS FOR ALL WIND DIRECTIONS ****

RECEPTOR	COORDINATES (M) X	Y	Z	TOTAL + AMB (PPM)
1. CUNARD BUILDING	68.	87.	1.8	3.7
2. PAX COMPUTER CENTER	78.	61.	1.8	3.4
3. COPYMAX INC.	42.	62.	1.8	2.4

EPA REGION I CAL03 INTERSECTION MODEL FOR CARBON MONOXIDE
ENHANCEMENTS FOR OVERCAPACITY QUEUING AND STOP SIGN CONTROL ADDED BY TECH ENVIRONMENTAL, INC.
CALINE3: CALIFORNIA LINE SOURCE DISPERSION MODEL - SEPTEMBER, 1979 VERSION PAGE 148

JOB: STATE STREET AND BROAD STREET RUN: CASE 1 8-HOUR

**** MAXIMUM CONCENTRATIONS FOR ALL WIND DIRECTIONS ****

RECEPTOR	COORDINATES (M) X	Y	Z	TOTAL + AMB (PPM)
1. CUNARD BUILDING	69.	87.	1.8	2.3
2. PAX COMPUTER CENTER	78.	61.	1.8	2.5
3. COPYMAX INC.	42.	62.	1.8	1.7

EPA REGION I CAL03 INTERSECTION MODEL FOR CARBON MONOXIDE
ENHANCEMENTS FOR OVERCAPACITY QUEUING AND STOP SIGN CONTROL ADDED BY TECH ENVIRONMENTAL, INC.
CALINE3: CALIFORNIA LINE SOURCE DISPERSION MODEL - SEPTEMBER, 1979 VERSION

JOB: STATE STREET AND BROAD STREET RUN: CASE 2 8-HOUR

**** MAXIMUM CONCENTRATIONS FOR ALL WIND DIRECTIONS ****

RECEPTOR	COORDINATES (M) X	Y	Z	TOTAL + AMB (PPM)
1. CUNARD BUILDING	69.	87.	1.8	1.3
2. PAX COMPUTER CENTER	78.	61.	1.8	1.3
3. COPYMAX INC.	42.	62.	1.8	0.9

EPA REGION I CAL03 INTERSECTION MODEL FOR CARBON MONOXIDE
ENHANCEMENTS FOR OVERCAPACITY QUEUING AND STOP SIGN CONTROL ADDED BY TECH ENVIRONMENTAL, INC.
CALINE3: CALIFORNIA LINE SOURCE DISPERSION MODEL - SEPTEMBER, 1979 VERSION

JOB: STATE STREET AND BROAD STREET RUN: CASE 3 8-HOUR

**** MAXIMUM CONCENTRATIONS FOR ALL WIND DIRECTIONS ****

RECEPTOR	COORDINATES (M) X	Y	Z	TOTAL + AMB (PPM)
1. CUNARD BUILDING	69.	87.	1.8	1.4
2. PAX COMPUTER CENTER	78.	61.	1.8	1.4
3. COPYMAX INC.	42.	62.	1.8	1.0

WORKSHEET 3--AREA SOURCE EMISSIONS COMPUTATION
(see instructions following)

Project No.: 99 State St. Analyst: Peak 1-hour

Site: 1990 Build Date:

Step	Symbol	Input/Units				
1	Brt	Base running time				
1.1		Base approach time(s)	4.7 (15mph)			
1.2		Base entrance time(s)	2.7 (1350 cars/hour)			
1.3		Base movement-in time(s)	68.4			
1.4		Base stop, base start time(s)	10.0			
1.5		Base movement-out time(s)	68.4			
1.6		Base exit time(s)	5.0 (2 booths @ 360 cars/hour			
1.7		Base departure time(s)	4.7 in PM peak hour.			
1.8		Total base running time(s)	163.9			
2	A	Area of parking lot (m^2)	NA			
3	i	Entrance approach identification	Ent			
4	Ve_i	Entrance demand volume (vph)	50			
5	Ce_i	Entrance approach capacities (vph)	1350			
6	i	Exit approach identification		Exit		
7	Vx_i	Exit demand volume (vph)		329		
8	Cx_i	Exit approach capacities (vph)		720		
9		Number of parking spaces occupied	N/A			
10	F	Emissions (g/s)	0.54			
11	Pc	Capacity of parking lot (veh)	N/A			
12	Rmi	Excess movement-in time(s)	0			
13	Fet	Facility emptying time(s)	N/A			
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio	0.04			
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio		0.46		
14.3	Re_i	Excess running time entering parking lot	0.1			
14.4	Rx_i	Excess running tire exiting parking lot		4.2		
15	Te_i	Total entering running time (s/veh)	83.0			
16	Rmo	Excess running time moving out of parking stalls (s/veh) *	0			
17	Tx_i	Total exiting running time (s/veh)		86.2		
18	Qa	Total emission rate from a parking lot (~~g/m²~~) (g/s)	4.88			
19	Qa'	Area source emission rate without the emissions from internal road segment, i				

* Attendant controls tandem spaces.

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WORKSHEET 3--AREA SOURCE EMISSIONS COMPUTATION
(see instructions following)

Project No.: 99 State St. Analyst: Peak 8-hour

Site: 1990 Build Date:

Step	Symbol	Input/Units				
1	Brt	Base running time				
1.1		Base approach time(s)	4.7			
1.2		Base entrance time(s)	2.7			
1.3		Base movement-in time(s)	68.4			
1.4		Base stop, base start time(s)	10.0			
1.5		Base movement-out time(s)	68.4			
1.6		Base exit time(s)	10.0	(1 booth @360 cars/hr)		
1.7		Base departure time(s)	4.7			
1.8		Total base running time(s)	168.9			
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification	Ent			
4	Ve_i	Entrance demand volume (vph)	88			
5	Ce_i	Entrance approach capacities (vph)	1350			
6	i	Exit approach identification		Exit		
7	Vx_i	Exit demand volume (vph)		157		
8	Cx_i	Exit approach capacities (vph)		360		
9		Number of parking spaces occupied	N/A			
10	F	Emissions (g/s)	0.26			
11	Pc	Capacity of parking lot (veh)	N/A			
12	Rmi	Excess movement-in time(s)	0			
13	Fet	Facility emptying time(s)	N/A			
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio	0.07			
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio		0.44		
14.3	Re_i	Excess running time entering parking lot	0.2			
14.4	Rx_i	Excess running tire exiting parking lot		7.7		
15	Te_i	Total entering running time (s/veh)	84.7			
16	Rmo	Excess running time moving out of parking stalls (s/veh)	0			
17	Tx_i	Total exiting running time (s/veh)		92.2		
18	Qa	Total emission rate from a parking lot (~~g/m-s~~) (g/s)	1.58			
19	Qa'	Area source emission rate without the emissions from internal road segment, i				